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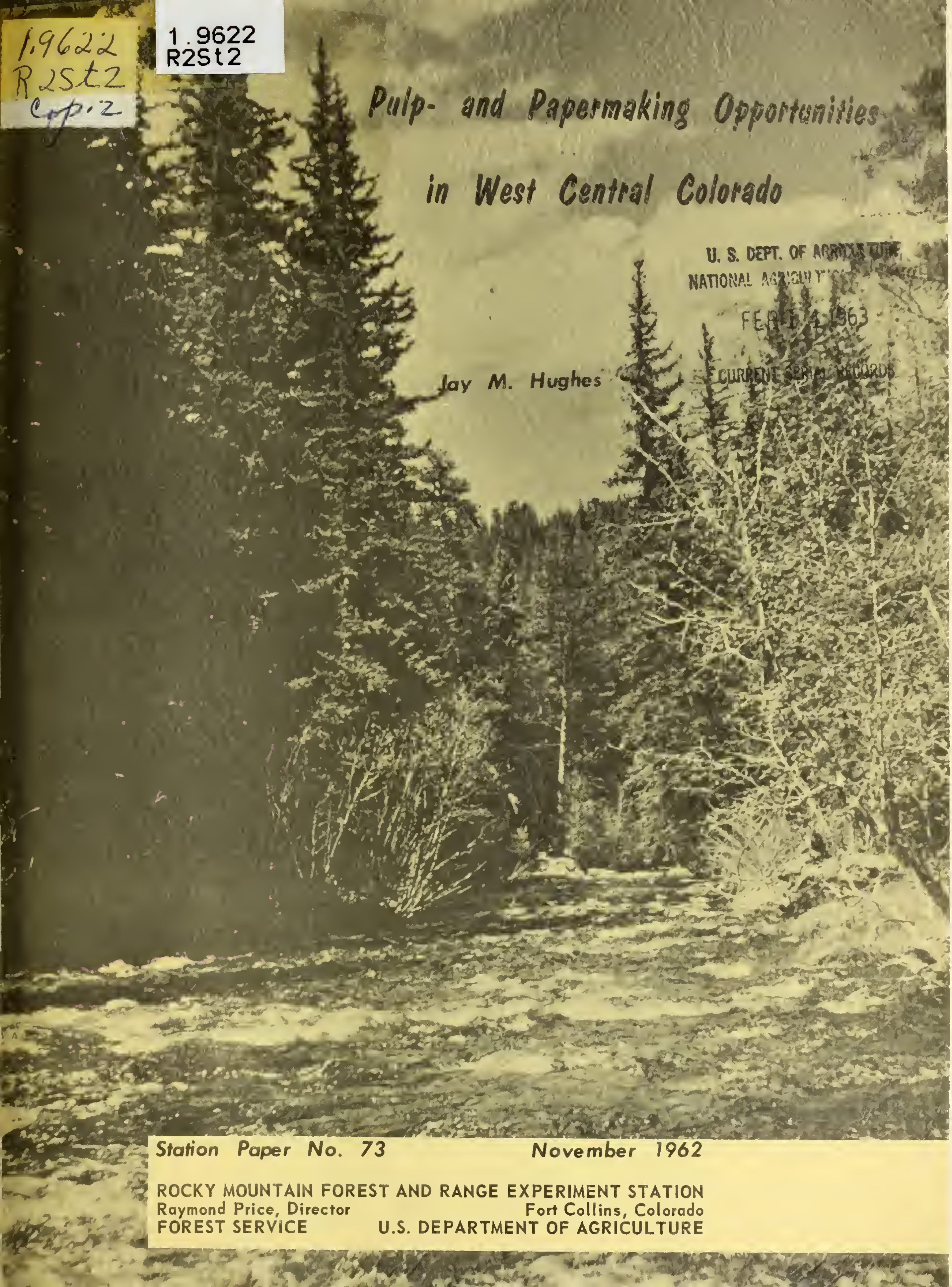

Pulp- and Papermaking Opportunities in West Central Colorado

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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
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FOREWORD

This report is an attempt to measure some of the key factors affecting pulp and paper industry opportunities in western Colorado. Foresters and other knowledgeable observers feel that this area offers one of the most favorable combinations of factors for pulp and paper-mill development in the Central Rockies. Important in this view are the suitability of local timber species for pulping, the relatively large volumes of wood in the area, the existence of a supply of surface water sufficient to support mills of feasible size, and a favorable location near growing western paper markets.

As a first step in evaluating the opportunities for pulp and paper industry development in this area, it was necessary to measure carefully the magnitude of development that reasonably could be supported by the available wood and water resources. In addition, the location of the wood with respect to likely millsites had to be determined in terms of reasonable estimates of pulpwood procurement costs.

Several persons and agencies have contributed to this study. The Division of Forest Economics Research at the Intermountain Forest and Range Experiment Station and the Rocky Mountain Region of the Forest Service were particularly helpful. The U. S. Public Health Service determined the capacity of the Colorado River to assimilate effluent and made estimates of its pulping capacity.

Details regarding specific sale areas and timber sale contractual matters can be obtained from the Regional Forester, U. S. Forest Service, Building 85, Denver Federal Center, Denver.

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PULP- AND PAPERMAKING OPPORTUNITIES IN WEST CENTRAL COLORADO

by

Jay Hughes, Research Forester

Rocky Mountain Forest and Range Experiment Station[1]

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[1] Central headquarters maintained at Fort Collins, in cooperation with Colorado State University.

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IN WEST CENTRAL COLORADO

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THE OPPORTUNITY IN BRIEF

Ample supply of wood

The current timber inventory of 6.7 billion cubic feet contains 29 million cords of live timber suitable for pulpwood. This could support an estimated production of at least 600 tons of newsprint daily. There are now no competing uses or markets for most of this pulpwood resource.

An additional 9 million cords of salvable dead pulpwood is concentrated adjacent to possible millsites. An estimated 50,000 tons of dry chips for pulping could be obtained from approximately 100 million board feet of lumber production a year. Expected expansion of the sawmilling industry would increase the chippable wood supply.

Ample supply of water

The Colorado River has enough pulpmill effluent assimilative capacity to sustain 2,000 tons a day of kraft or 360 tons a day of semichemical pulping distributed among four likely mill locations along the river. More than 20,000 tons a day of groundwood pulping similarly distributed along the river could be tolerated.

Water for pulp and paper manufacture is of acceptable quality, with minor or no treatment, and is generally available for diversion in the amounts needed.

Ample wood at moderate cost

Stump-to-truck costs, excluding stumpage and roads, will average $9 to $10 a cord. Total delivered cost of pulpwood can vary widely, although around 8 million cords of pulpwood can be obtained at Kremmling for less than $20 a cord, excluding stumpage and road costs. Six to seven million cords could be obtained at $20 a cord or less (excluding roads and stumpage) at three other assumed Colorado River millsites at Dotsero, Silt, and Fruita.

In addition, adjacent large and growing paper markets could be served at relatively low freight costs.

SCOPE OF THE STUDY

The emphasis in this report is on describing the timber inventory, establishing the general level of wood procurement cost, and setting up estimates of allowable mill capacities at some likely millsites based on the available water supplies. Other key factors have also been examined and are developed briefly. These include the markets for paper, fuels and power costs, labor costs, and taxes.

THE STUDY AREA

The commercial forests

This 13-million-acre Colorado headwaters area (fig. 1), including forested and nonforested land, is in west central Colorado and south central Wyoming.

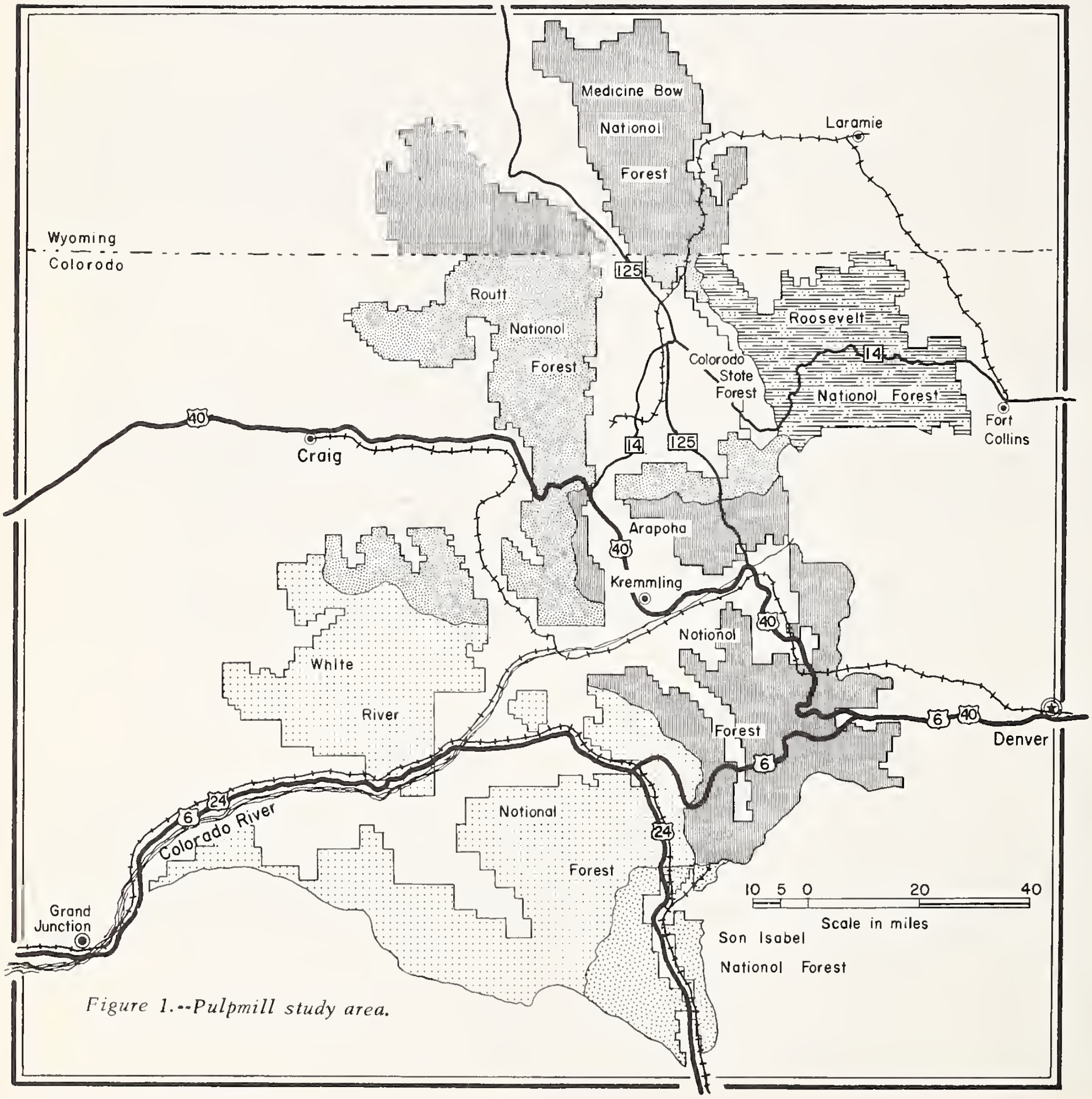

Figure 1.--Pulpmill study area.

Included within its boundaries are the upper main stem headwaters of the Colorado River and the source of the North Platte River. The 6 million acres that are inside National Forest boundaries are distributed as follows:

	Acres	
White River	2,076,443	
Routt	1,264,850	
Arapaho	1,061,225	
Roosevelt	650,000	(excludes Boulder and Estes Park Districts)
San Isabel	310,000	(Leadville District only)
Medicine Bow	710,000	(Medicine Bow Working Circle only)
Total	6,072,518	

About 80 percent of the commercial forest is within National Forest boundaries. Commercial forest land, as used in this study, includes land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. This includes both operable and currently inoperable areas. It does not include lands legally withdrawn from timber use such as National Parks, wilderness and primitive areas, or forest areas where topographical and other considerations are likely to prevent indefinitely management for timber production.

The physical shape and form of the commercial forest land is extremely varied (figs. 2-5), with elevations ranging generally between 6,000 and 11,000 feet above sea level. It is all physically operable by one means or another. Economic operability is another matter, which must be resolved on a case-by-case basis by both industry and resource managers.

Most of timber is lodgepole pine and Engelmann spruce – both excellent pulping species

The forests are mostly coniferous, containing the so-called softwoods such as lodgepole pine (Pinus contorta Dougl.) and Engelmann spruce (Picea engelmannii Parry). There is also a large volume of merchantable aspen (Populus tremuloides Michx.), a desirable pulping species in its own right (Hyttinen et al. 1960).[2]

Colorado River is most important source of surface water for pulping

Flowing southwest somewhat south of the center of the area is the Colorado River. Only this river has enough water to supply a chemical pulp and papermill

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[2] Names and dates in parentheses refer to Literature Cited, p. 34.

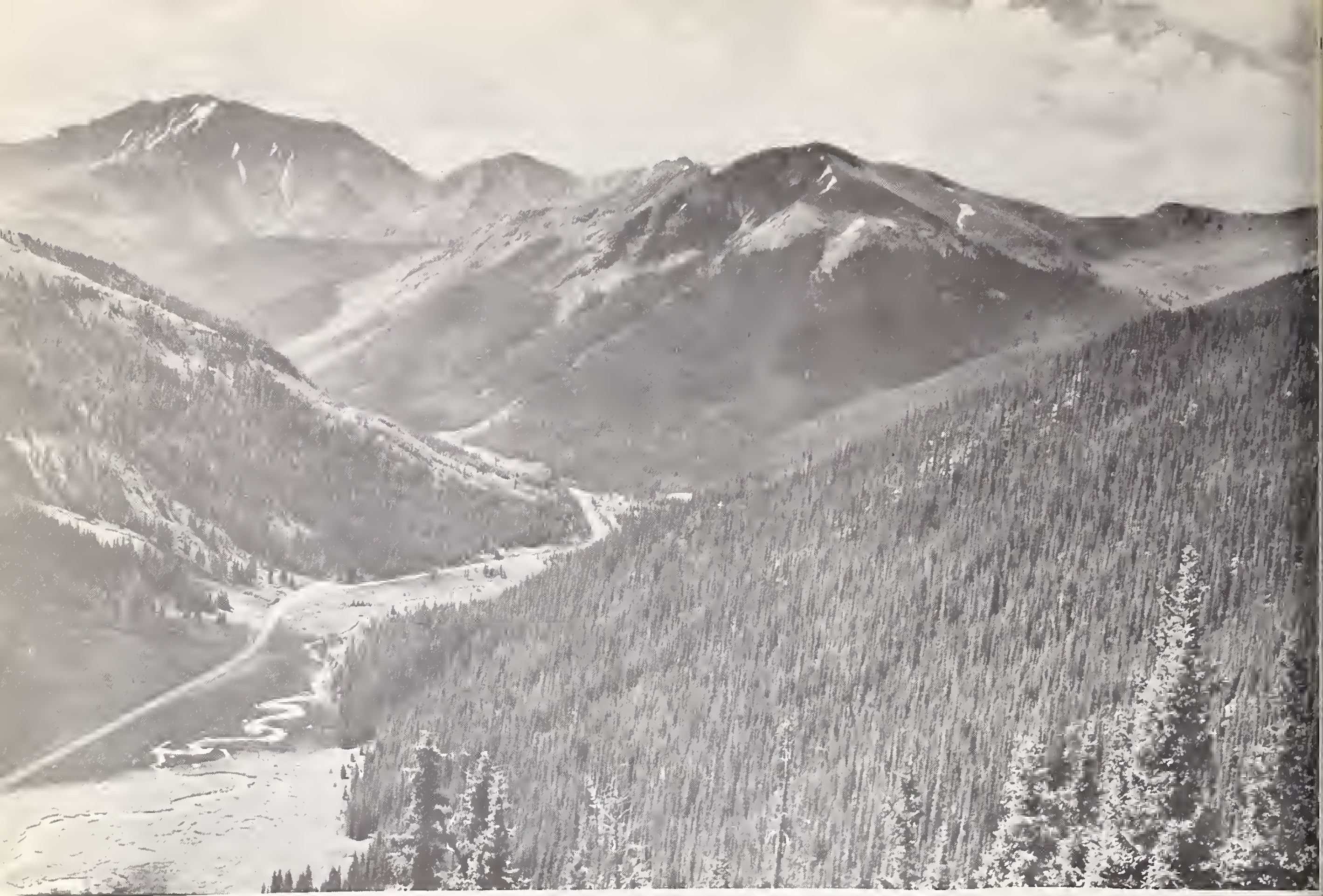


Figure 2.--The study area is fringed with rugged mountains, such as the Sawatch Range above, with commercial timber on the lower slopes.

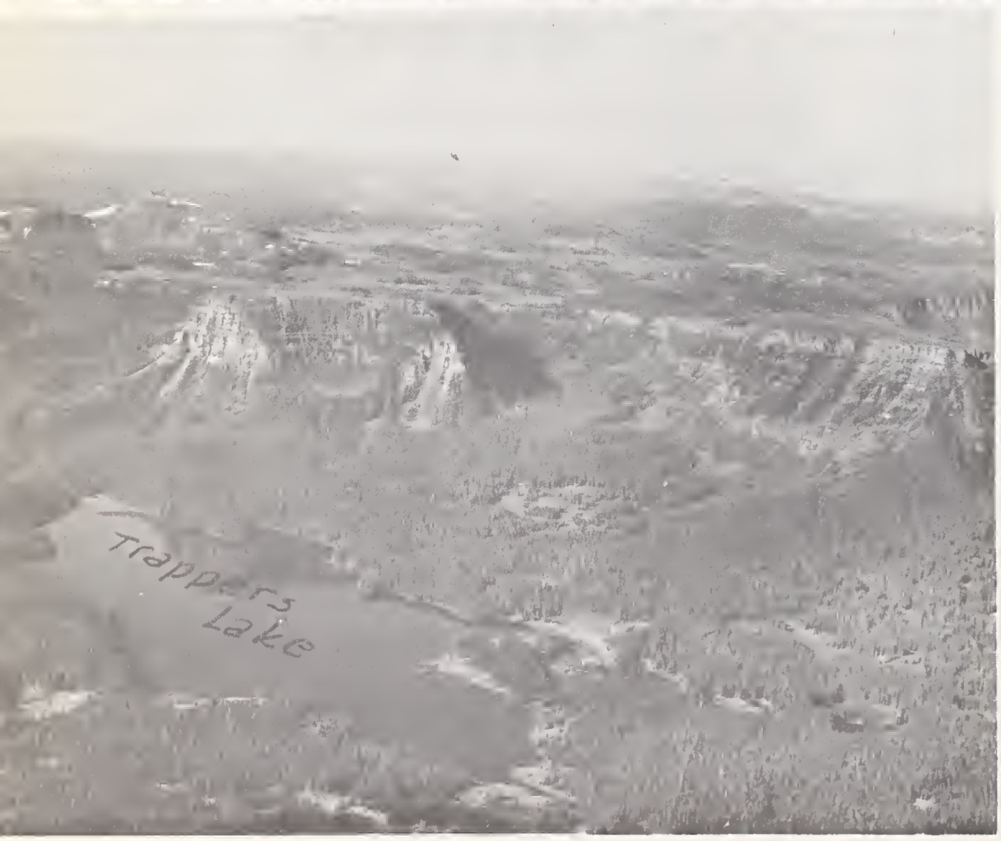


Figure 3.--By contrast, some billiard-tablelike plateaus, such as the White River flattops area (left), offer some of the easiest logging in the country.

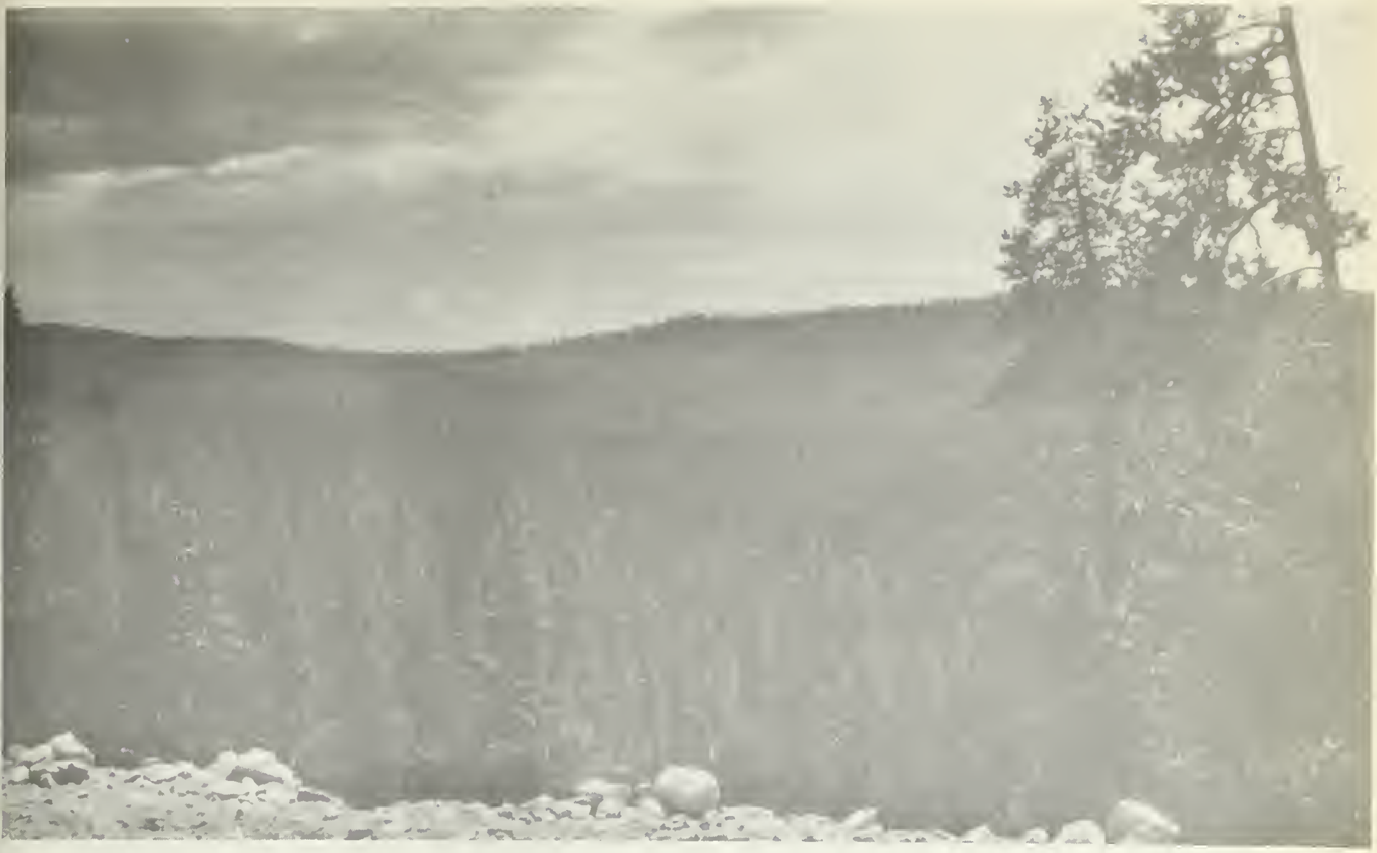
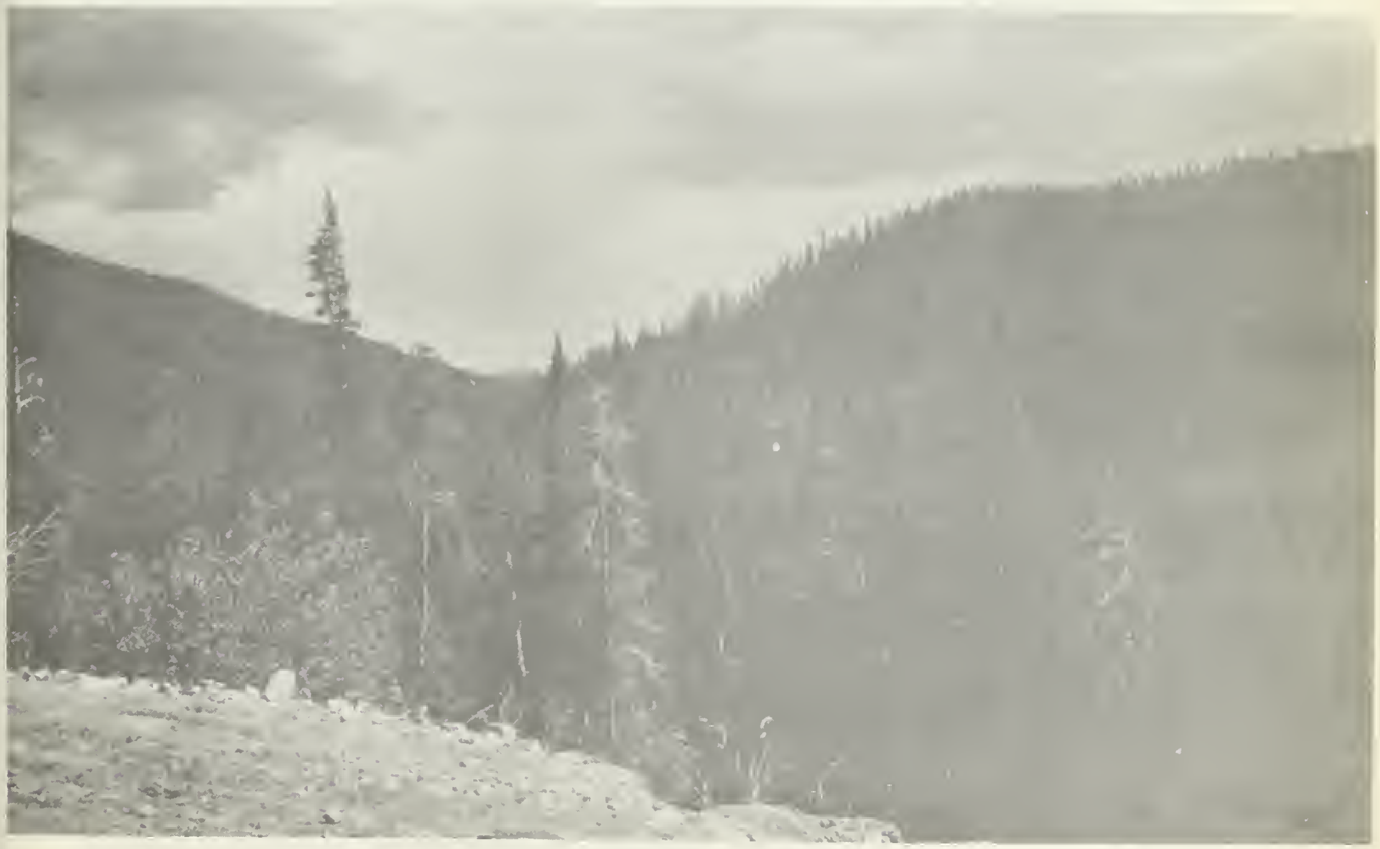


Figure 4, 5.--Most of the commercial forest, however, covers intermediate slopes like these on the Blue Ridge timber sale area on the Sulphur District of the Arapaho National Forest.



with its needs for processing pulp and diluting the mill wastes. There are several tributaries, however, that carry enough water to support substantial volumes of groundwood pulping.

In certain parts, mostly upstream from the most desirable pulpmill sites, the Colorado is a superb trout fishery and sport fishing is big business in Colorado. Below its confluence with the Eagle River are substantial diversions for agriculture and industry. Domestic use of the Colorado River water in this area is negligible. Streamflow patterns may be affected by present and prospective diversion and storage projects of benefit to both east and west slopes of the Rockies. In spite of these uses, however, there is plenty of water in the Colorado River for substantial pulp and paper industry development.

Total population is small and scattered among many small towns, although large population centers – and markets for paper – are nearby

The area is essentially rural, with more than 50 percent of the population living in towns under 2,500 population. The three largest towns range downward in population from 10,000 to 3,000.

East of the Continental Divide, however, lies the Denver trade area with nearly a million people. The city of Denver with 500,000 population is only 100 miles from Kremmling by U. S. Highway 40, only a few hours by train, and less than an hour by plane. Nearly 400,000 more people are clustered around Denver in three adjacent counties. Not far to the west by modern travel standards is the Utah population complex of Ogden, Salt Lake City, and Provo with a third of a million people. Moreover, highways, rail, and air transportation services combine to put many other major population centers in the west and midwest within convenient travel and freight distance.

Lumber and wood-products industry is an important employer

A large portion of the population in the study area depends on the lumber and wood-products industry for its livelihood. In 1958, two-thirds of the manufacturing firms in the area were natural resource-oriented (U.S. Bur. Census 1961). Thirty-seven percent of the total were in the lumber and wood-products industry.

National Forest stumpage dominates

Of the 5 million acres of stocked commercial forest, 84 percent is inside National Forest boundaries (table 1) and 73 percent is in National Forest lands. Private ranch and farm land accounts for most of the balance. Unreserved State, other private, county and municipal, and other Federal lands make up the remainder of the commercial forest.

Stumpage thus comes mostly from National Forests. Recent studies suggest that timber production from privately owned timberlands is only a minor purpose of land ownership.[3] [4]

At least one-third of the 6.7 billion net cubic foot inventory of live green wood is suitable for pulpwood[5]

When the "dead spruce type"[6] is excluded, a little more than 6.7 billion net cubic feet of wood are stored on the stump in the current inventory of live green timber 5.0 inches d.b.h. and larger. About one-third of this volume is considered suitable for pulpwood. This allocation was made on the basis of standards of general product suitability of the various sizes of trees and species found in the current inventory and reflects the fact that some sawtimber-size material will be utilized for pulpwood. It also reflects the fact that some pole-size timber 9.0 to 10.9 inches d.b.h. can be utilized for lumber products such as 2- by 4-inch studs. Figure 6 shows the relative volumes allocated to the two broad product classes of sawtimber and pulpwood by diameter class.

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[3] Garrison, Verne L. Primary problems involved in marketing privately owned stumpage in west-central Colorado. 1958. (Unpublished master's thesis on file at College of Forestry, Colo. State Univ., Fort Collins.)

[4] Knudson, Douglas M. Private stumpage marketing in western Colorado. 1960. (Unpublished master's thesis on file at College of Forestry, Colo. State Univ., Fort Collins.)

[5] For comparative yield, volume of solid wood content per cord, and wood density factors, see table 8, p. 39.

[6] A type designation coined by Forest Survey for a distinct area of concentrated beetle-killed timber. This timber was killed during the 1939-51 epidemic reported elsewhere. Although mortality is found in all of the stands of the area, the dead spruce type is unique inasmuch as most of the wood volume is in stems killed during the epidemic. It should be considered an artificial type, however, since it is the relatively temporary result of a natural disaster.

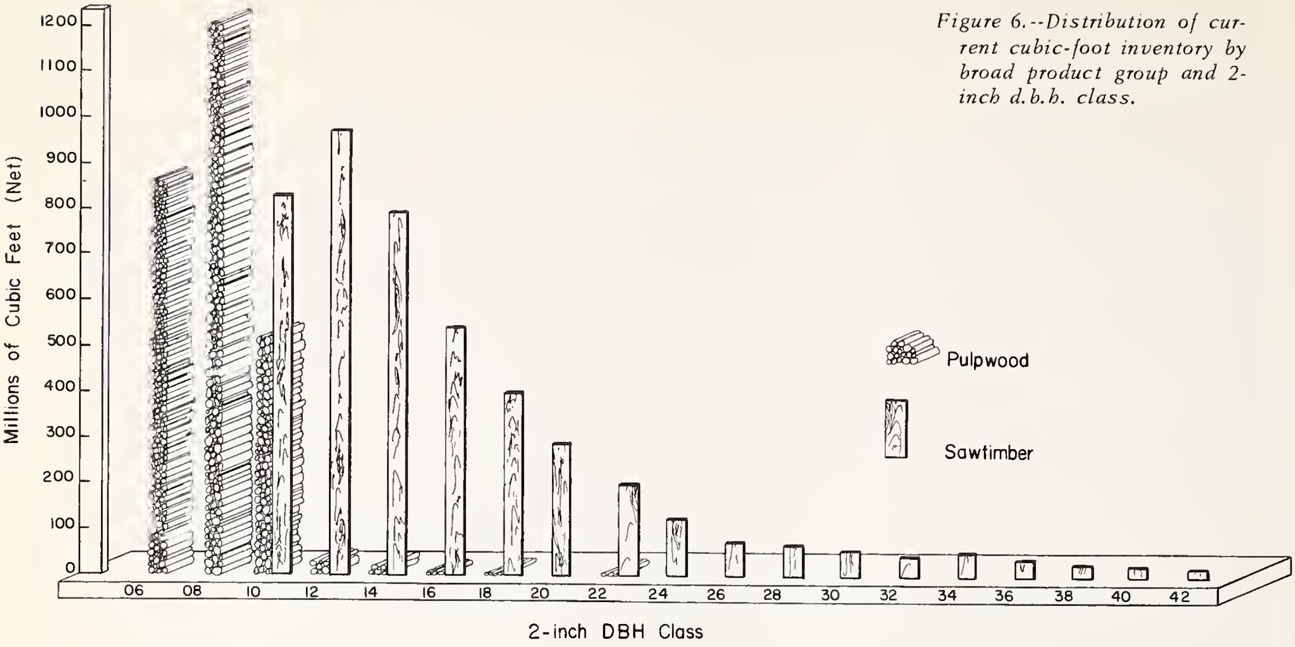


Figure 6.--Distribution of current cubic-foot inventory by broad product group and 2-inch d.b.h. class.

Table 1.--Unreserved commercial forest area inside and outside National Forest boundaries, by type and stand-size class
(Dead spruce type and nonstocked areas[1] excluded)

Forest type	Sawtimber		Poletimber		Seedlings and saplings		Total
	Inside	Outside	Inside	Outside	Inside	Outside	
				Acres			
Lodgepole pine	630,862	119,445	970,473	198,988	79,311	11,585	2,010,664
Spruce-fir	808,356	36,291	204,827	13,218	17,408	--	1,080,100
Ponderosa pine	63,519	31,673	66,219	1,990	120	--	163,521
Douglas-fir	52,835	91,315	35,014	29,969	20	1,098	210,251
Other conifers	1,240	10,381	5,447	1,129	620	--	18,817
Aspen-hardwood	37,218	20,339	645,584	377,714	116,982	57,652	1,255,489
Total	1,594,030	309,444	1,927,564	623,008	214,461	70,335	4,738,842

[1] Nonstocked areas total 73,331 acres, mostly of the spruce-fir type.

Any individual pulpwood offering, however, may include both sawtimber- and poletimber-size trees in order to make an economical offering of material. This will in turn influence procurement costs.

Lodgepole pine makes up almost half of the 28.8 million cord current inventory of live green pulpwood

The area dominance by lodgepole pine is shown in figure 7 and in the estimate of total pulpwood volumes in the current timber inventory (table 6, p. 38). More than 13.6 million cords of lodgepole pine pulpwood (fig. 8) could be removed from the current inventory of 28.8 million cords of live green pulpwood on the National Forests. Foresters have known for some time that lodgepole pine is a desirable pulping species by all standard pulping processes (Zischke 1956), and its recent use in pulpmills in the Pacific Northwest and Inland Empire has reinforced its acceptability. Engelmann spruce, subalpine fir (Abies lasiocarpa (Hook.) Nutt.) and aspen account for 48 percent of the current inventory pulpwood volume. Other coniferous species contribute less than 5 percent of the total.

Poletimber dominates the stand-size class distribution of the current inventory (fig. 9).

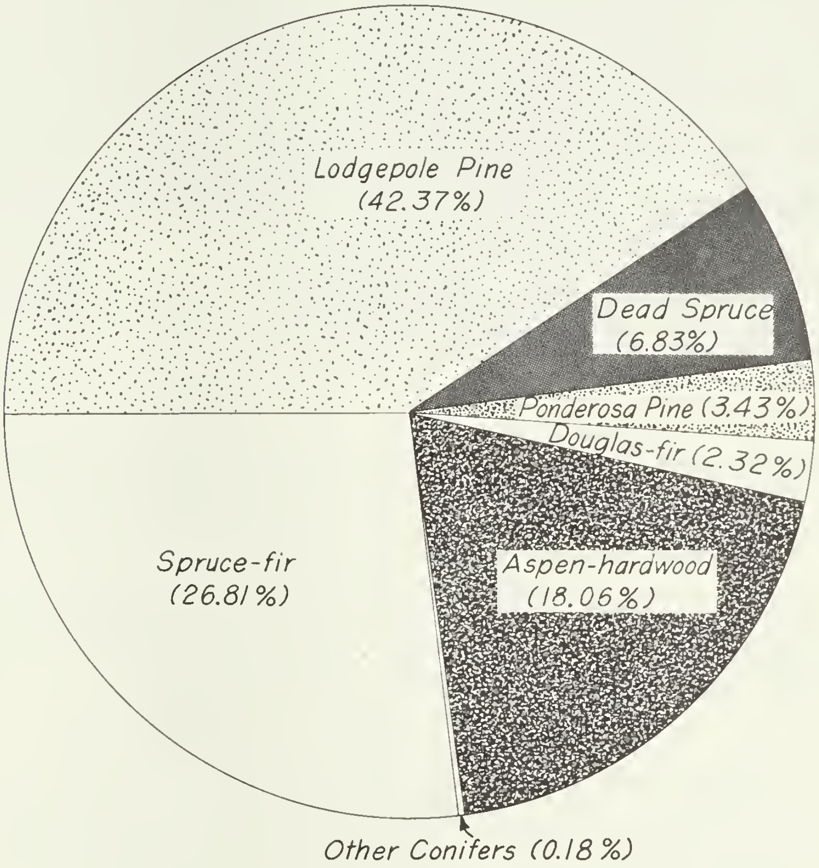


Figure 7.--Proportion of commercial forest area by type.

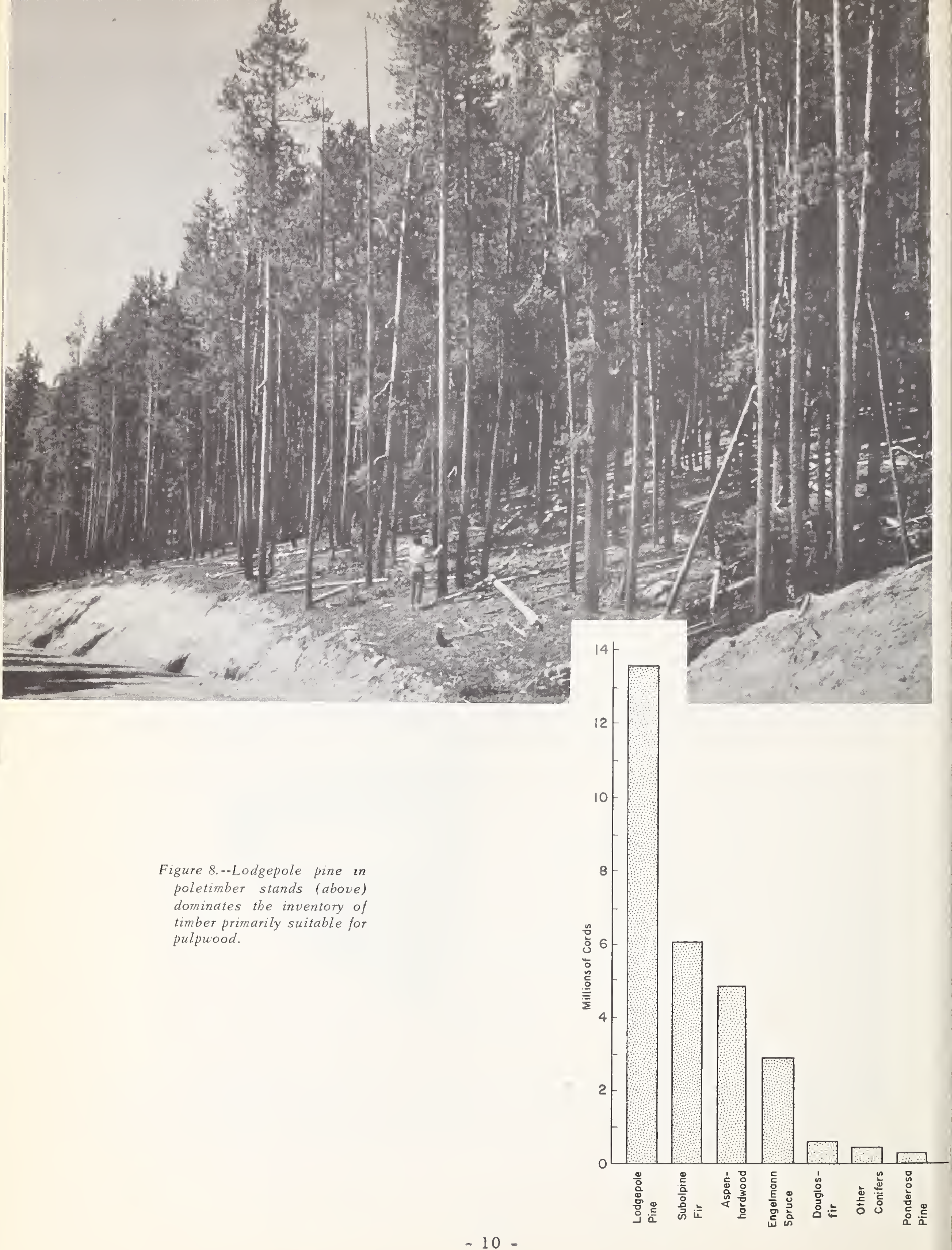


Figure 8.--Lodgepole pine in poletimber stands (above) dominates the inventory of timber primarily suitable for pulpwood.

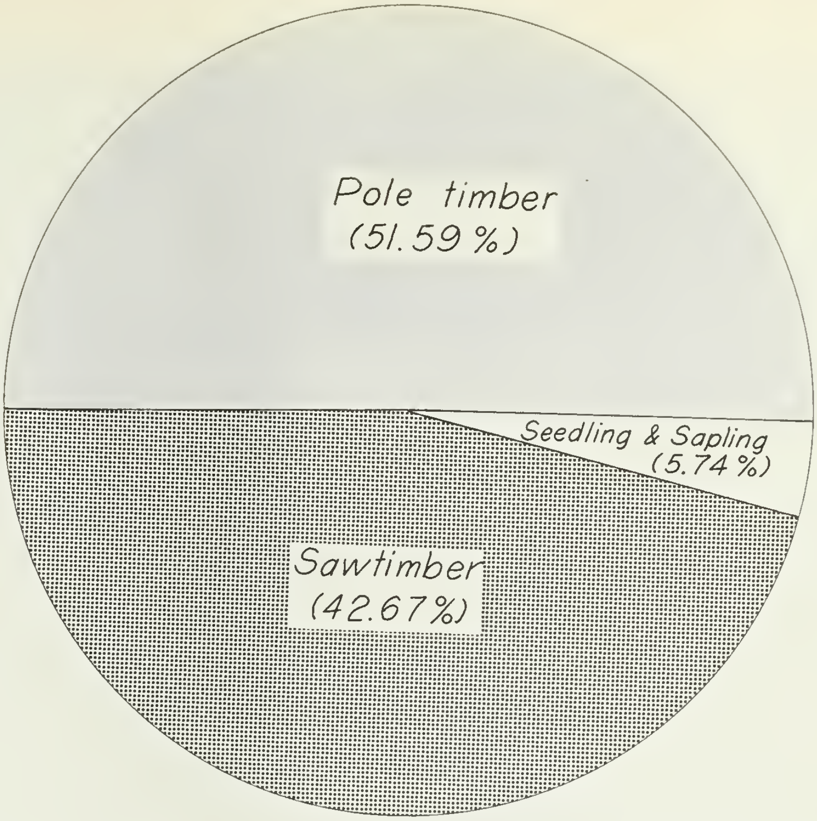


Figure 9.--Distribution of commercial forest area by stand-size class.

Dead spruce type is minor but unique

The so-called dead spruce type (figs. 10 and 11) occupies 258,000 acres, or 7 percent of the commercial forest. Although this dead timber is now considered of little value for lumber manufacture, it has several attractive features as a pulpwood resource. For one thing, there are more than 9 million cords of salvable dead pulpwood in a relatively concentrated area within a reasonable trucking distance to possible pulpmill sites. Much of this type is on flattopped mesas where logging would be easy. Average volumes per acre are high, and range from 35 cords per acre on the White River National Forest to 38 cords per acre on the Routt. Most of this volume is in sawtimber-size trees.

Since this forest type is composed of large, dead trees, weight per cord is low--about 2,600 pounds--and solid wood content is high--around 95 cubic feet. Moreover, tests at the Forest Products Laboratory are conclusive about the acceptable quality of pulp made from sound insect-killed spruce (Schafer 1953, Schafer et al. 1956). This insect-killed spruce can also be converted into particle board of competitive quality (Mueller 1959). Included in the dead spruce type are 1,038,464 cords of live green pulpwood and nearly 849 million board feet of live sawtimber. This live portion of the dead spruce type is dominated by subalpine fir, also a desirable pulping species.

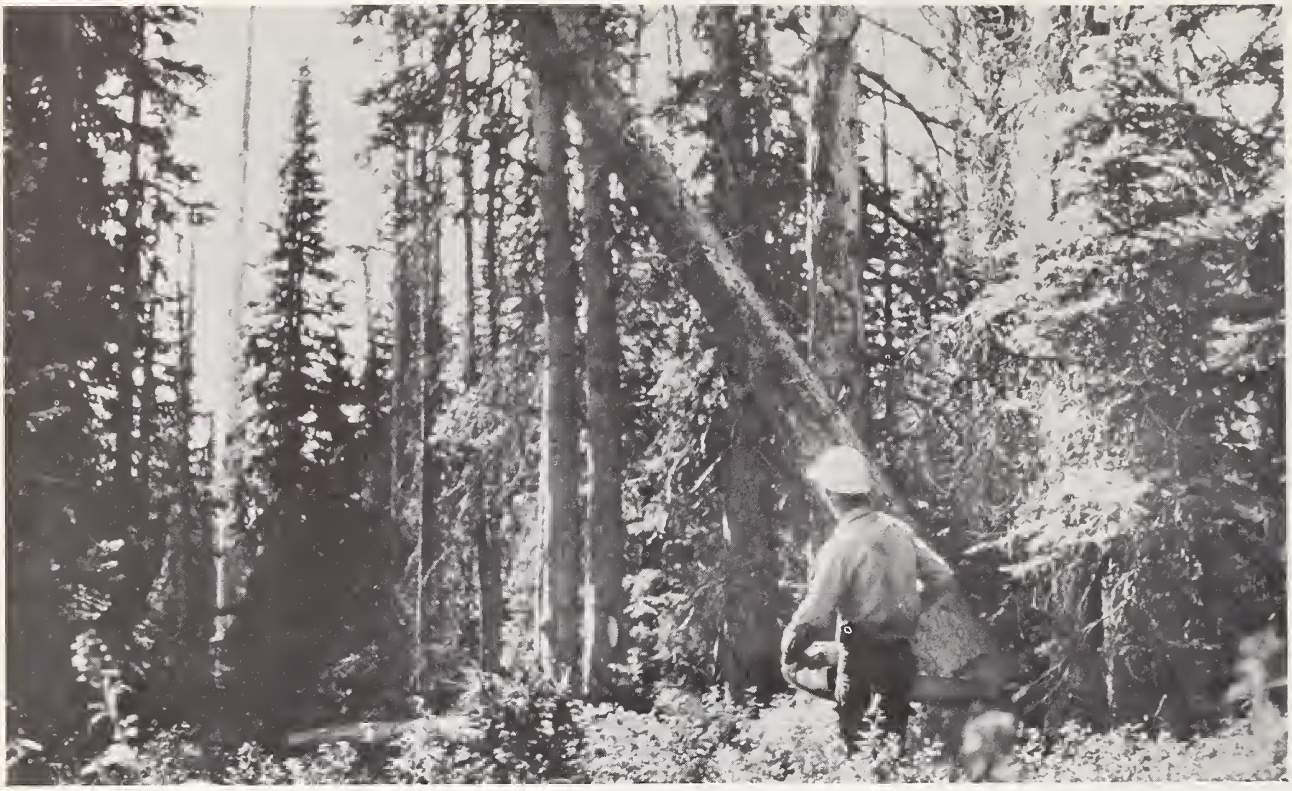


Figure 10.--The dead spruce type on the White River National Forest has attracted nationwide attention, and represents added opportunity for pulpwood harvest.

How long this dead wood will last or remain pulpable is not known. Recent investigation of deterioration of beetle-killed spruce in Colorado suggests that perhaps as much as a third of the original beetle-killed volume has already been lost to decay and windthrow (Hawksworth and Hinds 1959). Spruce killed and standing dead for 20 years on the Aquarius Plateau in Utah made good pulp at the Forest Products Laboratory, however (Schafer et al. 1956). Apparently most of the wood in killed trees will remain sound for pulping as long as the tree remains standing.

Engelmann spruce dominates the sawtimber inventory

The current inventory of live trees contains 22.5 billion board feet of merchantable sawtimber. Forty percent of this merchantable sawtimber inventory is Engelmann spruce, an excellent species for both lumber and pulp production (fig. 12, table 7, p. 39). Lodgepole pine accounts for another 38 percent of this sawtimber,

Figure 11.--Only a fraction of the pulpwood resource in the dead spruce type has been logged.

with the remaining 22 percent made up of subalpine fir, aspen, Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn.) Franco), ponderosa pine (Pinus ponderosa Lawson), and other conifers.

In short – there is enough wood for a substantial pulp production

The size of the current inventory of wood for pulp and other products represents a vast reservoir of wood fiber for industry. A minimum annual pulpwood cut of 220,000 cords a year, equivalent to 300 tons of sulfate pulp daily, is possible. This is a minimum. The ultimate size of pulp industry that can be sustained by the timber resource is still an open question. The speed with which the current inventory is liquidated, the amount of silvicultural work done in young stands, future yields obtainable from cutover areas, and product demands in the future--all have a place in the allowable cut equation.

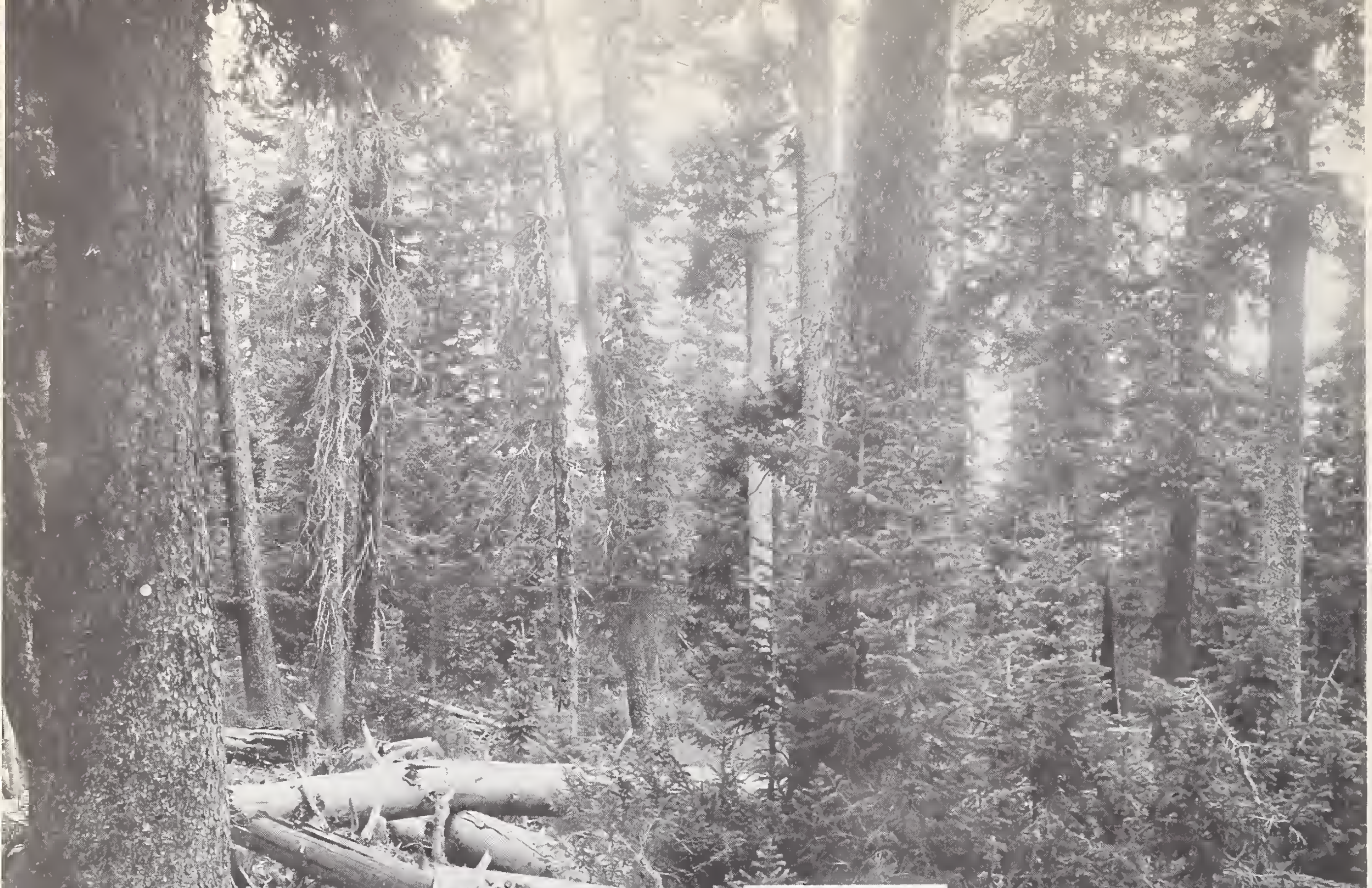
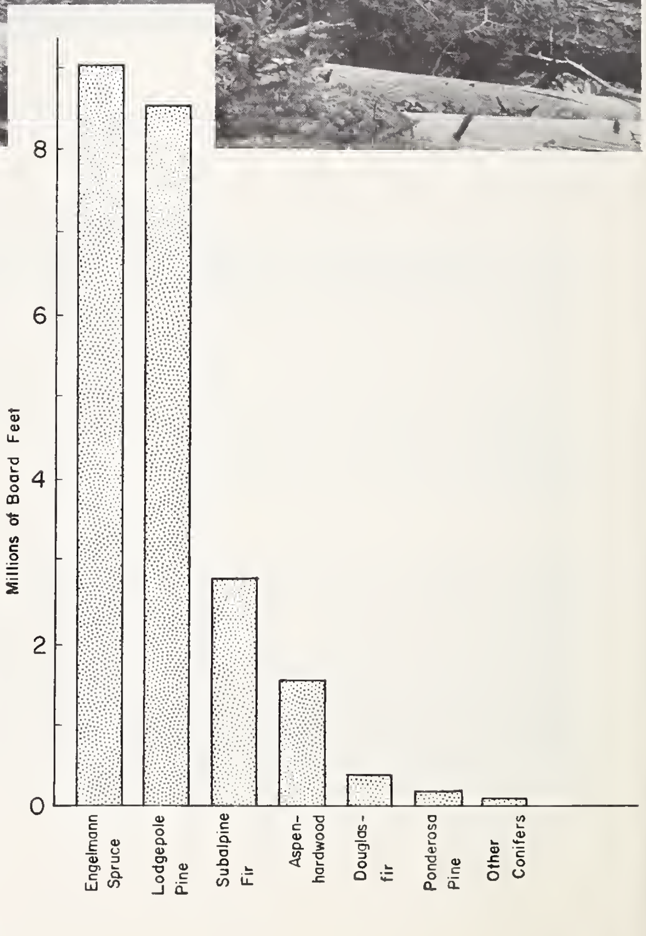


Figure 12.--Engelmann spruce in stands like this is the major species in the saw-timber inventory.



WATER SUPPLY AND PULPMILL CAPACITY

The Colorado River flows the largest volume of surface water in the State (fig. 13). Water-resource data are given in the appendix, pp. 40-42.

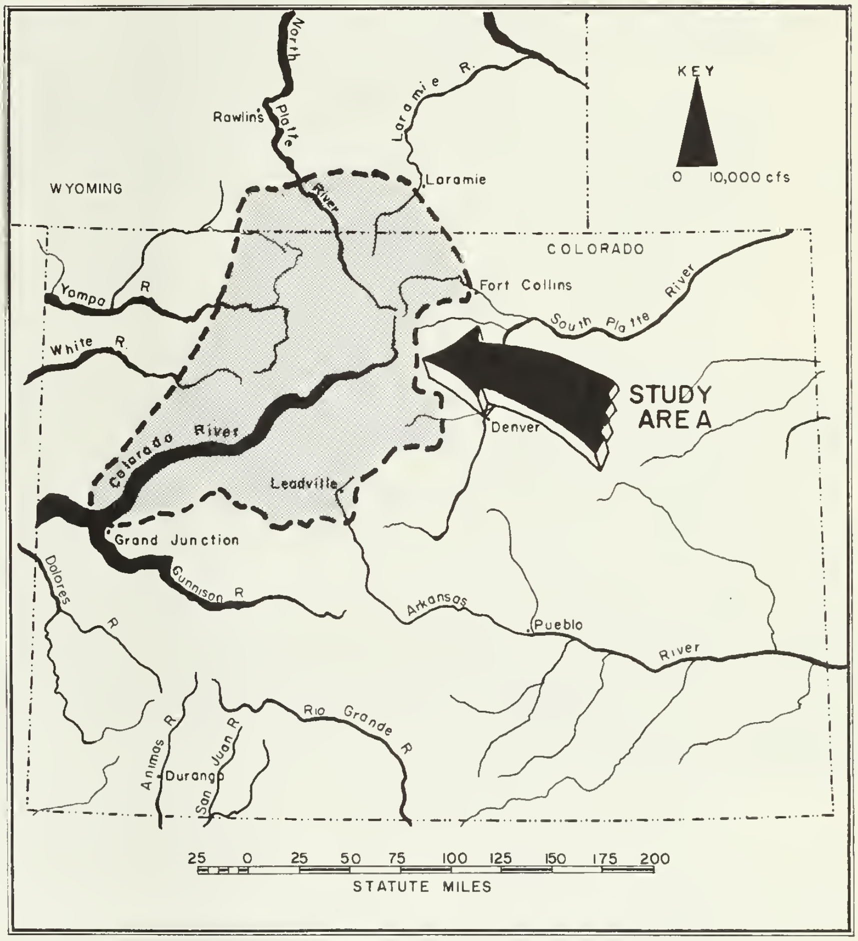


Figure 13.--Major surface water resources of Colorado and study area.

According to the Colorado Water Conservation Board, there is enough unappropriated water flowing in the Colorado River downstream from its confluence with the Eagle River to support pulpmills of minimum economic size or larger. Upstream from this river junction enough can be made available through water exchange agreements, purchase of property with water rights, or by other means.

Groundwater for pulping was not considered because of the general availability of surface water.

Effluent assimilative capacity of surface water supply will permit substantial pulp- and papermaking capacity

Pulping requires relatively large quantities of process water, although it is essentially nonconsumptive insofar as water volumes are concerned. Even larger quantities of water than needed for processing must be flowing in the stream, however, simply to dilute the wastes discharged from the pulpmill. Approximate water-volume requirements for pulp and paper processing (Gaudy 1957, p. 38; Mussey 1955, p. 32) are as follows:

	Groundwood	Semichemical	Sulfate
	- - - (Gallons per ton of pulp) - - -		
Pulpmill	1,000	3,000-20,000	20,000-40,000
Bleaching	1,000		
Partial		20,000	20,000
Full		40,000	40,000
Papermill	7,000-10,000	10,000-25,000	10,000-20,000

Water for debarking will vary from 0 to 7,500 gallons per ton of pulp, depending on pulping technique, process used, and equipment.

Pollution is a technically complex subject; however, with regard to pulpmill pollution of water, the most important factor is the demand of organic mill wastes upon the dissolved oxygen content of the receiving water. This oxygen-depletion characteristic is called Biochemical Oxygen Demand (BOD). Because Colorado River water is used as a domestic water supply by two adjacent towns, Colorado State Health Department regulations state that waste loads discharged to the river must not exceed a 5-day 20°C. BOD of 30 parts per million (p.p.m.). BOD characteristics of various pulping processes assumed applicable in the Colorado River study area follow:

	5-day 20°C. BOD (Pounds per ton of pulp)
Sulfate	50
Groundwood	3- 10
Semichemical:	
No chemical recovery	275
Chemical recovery	25-140

A more detailed breakdown of BOD sources for a typical kraft pulp and papermill is shown in table 9, p. 40.

The U. S. Public Health Service studied the pulpmill effluent assimilative capacity of selected stream stretches, and has summarized the results (Pahren and Towne 1960). The following discussion highlights some of the pertinent aspects of that study.

In the PHS study, dissolved oxygen levels to sustain fish life (about 5 p.p.m.) were used as minimum quality standards for surface water. Estimates of total dissolved oxygen during critical (low oxygen-low flow) flow periods are shown in table 11 p. 42. The effect of this minimum quality standard, assuming certain levels of waste treatment by pulpmills, is to raise water volume requirements many times. However, the Colorado River has enough water with adequate dissolved oxygen to accommodate both pulpmill effluent and trout if reasonable levels of waste treatment are maintained by the pulpmill.

In Colorado, two State agencies have responsibility for the maintenance of water quality. The agency with primary responsibility for water pollution control is the Colorado Department of Public Health. Effluent standards rather than stream standards are used by this agency for regulating waste loads under existing laws and regulations. The other State agency with statutory responsibility for water-pollution control is the Colorado Game and Fish Department. Any party interested in establishing a pulpmill in Colorado based on the surface water resource of this State should clear its water use and waste treatment plans with these two agencies. The pertinent laws and regulations have been summarized and discussed elsewhere, and may be obtained by contacting the two agencies indicated above.

Estimates of allowable plant capacity (table 2) assume that Colorado State Health Department effluent regulations are met by each process design. It has been recommended that effluent storage lagoons be built at each site for storage of wastes in the event of a process breakdown (Pahren and Towne 1960). Moreover, it has been recommended that in the event two or more mills are built in this area, care should be taken to keep the mills far enough apart to prevent overtaxing the assimilative capacity of the stream stretch involved.

Estimations of allowable plant capacity are additionally based on maximum levels of BOD which can be permitted during August, the critical month of the year. August, because of lower flows (though not the lowest) and higher water temperature, is the month during which the lowest dissolved oxygen levels may be expected. The estimates of allowable mill capacity are based on assumed process designs and levels of waste treatment. Thus it is important that each mill proposal be evaluated separately on its own merits in terms of waste-treatment requirements.

Several of the most likely stream stretches in the study area and two stretches in the Gunnison drainage south of the study area were examined. These stretches are briefly discussed below. Flow of water, existence of transportation facilities, availability of power and fuels, and industry interest in the four Colorado River stretches were the major factors considered in selecting stream stretches for analysis. Another factor worthy of special mention is that few flat places along the Colorado River are large enough to accommodate mills and wood-holding grounds. The stretches selected for analysis contain most of the desirable sites from this viewpoint. The White River stretch from Buford to Meeker was analyzed but is not considered a desirable location for a pulpmill because of its value as a trout fishery and its lack of rail transportation.

Colorado River from Parshall to Kremmling. --A site near Kremmling would require limited storage facilities for regulating release of effluent during

Table 2.--Estimated allowable pulpmill capacity at selected river stretches in western Colorado[1]

River and stretch	Pulping process		
	Sulfate	Semichemical	Groundwood
	- - - - - Tons of pulp per day - - - - -		
Colorado:			
Parshall-Kremmling	350	60	1,000+
Sweetwater-Dotsero	600	110	1,000+
New Castle-Rifle	650	115	1,000+
Grand Junction-Fruita	400	75	1,000+
White:			
Buford-Meeker	0	0	700
Eagle:			
Eagle-Gypsum	0	0	1,000
Gunnison:			
Gunnison-Delta	0	0	600
North Fork-Gunnison:			
Somerset-Hotchkiss	0	0	700
Total	2,000	360	([2])

[1] These estimates are mutually exclusive. That is, 350 tons of sulfate pulping at Kremmling would exclude the production of any other kind of pulp at the same site. Product capacity, such as newsprint, must be estimated separately by means of appropriate pulp combinations. The degree of bleaching will also affect these allowable capacities inasmuch as added bleach wastes must also be diluted.

[2] Exact totals were not provided by the U. S. Public Health Service, but they are considerably greater than the 7,000 tons a day shown here and can be computed from the data in tabulation on page 16 and table 11, p. 42.

fluctuations in flow of the river. This would probably be the most critical stretch of the Colorado River from a fisheries standpoint.

Colorado River from Sweetwater to Dotsero.--The major problem in this stretch is the possible effect the mill waste will have on operation of the Shoshone power plant downstream from Dotsero.

Colorado River from New Castle to Rifle.--Rifle and DeBeque both take their domestic water supplies from the Colorado River. It may therefore be necessary for any mill located in this stretch to provide high levels of waste treatment. Also, this area is involved in the potential shale oil industry development near Rifle. If this development becomes a reality, estimates indicate a new population of 340,000 for the area by 1975 and a need for a water supply of 252,000 acre-feet a year for industrial and domestic requirements (Cameron and Jones 1959). According to the U. S. Public Health Service, reservation of river assimilative capacity for this development would limit sulfate pulping capacity to 500 tons a day. Although a large dam and reservoir has been proposed for DeBeque, with attendant drastic changes in river flow characteristics for this stretch, the chance of development of this project seems very remote according to U. S. Bureau of Reclamation officials in Denver.

Colorado River from Grand Junction to Fruita.--This stretch was included in the analysis for two reasons in addition to those cited earlier. One is that it is geographically situated to draw on the forest resource of the Gunnison River basin as well as parts of the study area. Moreover, it is downstream far enough to avoid, for the most part, conflicts with other uses, particularly recreation. A lower level of oxygen (4 p.p.m.) was used in making the estimate for this site because trout do not exist this far downstream. Nevertheless, in spite of the relatively high volume flows of water below the confluence with the Gunnison River and the lower oxygen level required to sustain existing aquatic life, effluent assimilative capacity was less than anticipated. There are two principal reasons for this. One is the high temperature of the water during the critical month. The other reason is that there is already a heavy oxygen demand on the water here. In addition to a gilsonite plant near Fruita which uses the water of this stretch, this is an area of high return flow from irrigation. Chemical pulpmills could not be built here if a minimum dissolved oxygen content of 5 p.p.m. for the stream were insisted upon.

Eagle River from Eagle to Gypsum.--Only groundwood pulping can be tolerated in this stretch and the remaining two stretches because of small volume flows for dilution of effluent. This is also a trout fishery.

Gunnison River from Gunnison to Delta.--The most feasible pulpmill site located in this stretch of river would be in the immediate vicinity of Delta. The 600-ton per day groundwood pulping capacity estimated for this location could possibly be increased to 700 tons a day if the town of Delta installed secondary sewage treatment facilities.

North Fork of the Gunnison River from Somerset to Hotchkiss.--Although flows here are not great now, they will be increased and regulated when the Paonia Project upstream is completed by the U. S. Bureau of Reclamation. Because of the effect of irrigation diversions upstream, the best site location would be as near Hotchkiss as possible. Figure 14 shows allowable sulfate capacity at the four assumed Colorado River sites.

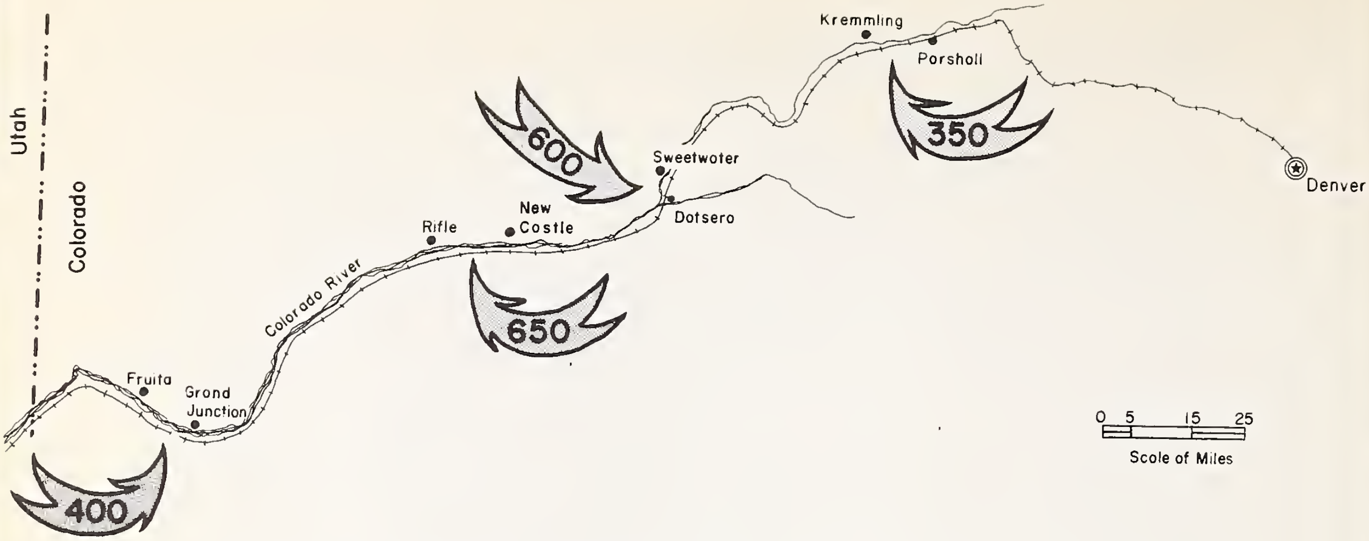


Figure 14.--Tons per day of sulfate pulp production that can be supported by streamflow along selected Colorado River stretches.

Process water quality appears satisfactory

The water used in the processing of pulp and paper must meet certain quality standards so that product quality and processing equipment will not be impaired or damaged. Tentative specifications for the maximum permissible amount of certain chemical constituents of process water for various products, as established by the Technical Association of the Pulp and Paper Industry (TAPPI 1948a, 1948b, 1953), are summarized in table 12, p. 42.

Although several of the constituents of Colorado River water are frequently excessive, they do not present serious problems. Some treatment will be required, however, with the degree of treatment dependent upon location of plant and quality of product produced. The amount of treatment required would apparently be much less above the confluence of the Eagle and Colorado Rivers.

To appraise plant investment costs fully at any particular site, it will be necessary to analyze the quality of process water available at the site to determine the kind and degree of water treatment required.

COST OF PULPWOOD PROCUREMENT

The economic opportunity for developing this timber resource is partly described by identifying the kinds and levels of costs that will be incurred in getting the wood off the stump and to the processing plant. Stumpage values will not be discussed herein since they will reflect the detailed appraisals of specific sale areas as well as market and competitive conditions among timber operators at the time of sale.

Estimated stump-to-truck costs comparable to other pulpwood-producing areas

There is no current pulpwood logging experience in this area upon which to base costs. However, pulpwood logging costs for presently producing U. S. areas have been modified to reflect likely levels of costs in this area.

The combined cost for felling, bucking, skidding, loading, and other costs incidental to the logging operation may range from $9 to $10 per cord, and vary by species as follows:

Dead spruce	$ 9.35
Live spruce	9.90
Lodgepole pine	10.23
Aspen	9.23

These costs compare with stump-to-truck costs in other areas as follows:[7]

Pacific Northwest, 1959-60:		
	Lodgepole pine	$12.98
	Spruce	10.00
Lake States, 1960:		
	Pine	8.29
	Spruce	11.06
	Aspen	8.47
Southern States, 1959:		
	All species	8.75

Estimates of hauling cost vary with hauling distance

In important respects the significant variable influencing hauling cost--from the standpoint of comparing opportunities in different resource areas--is hauling distance. Therefore, truck hauling costs and road maintenance charges were estimated by a technique that relates average costs for hauling and road maintenance to hauling distance. The estimated roundtrip truck cost per cord of pulpwood hauling at selected distances, including road maintenance charges are:

10 miles	$4.04	40 miles	$ 6.76	90 miles	$11.16
15	4.89	50	7.45	100	11.60
20	5.54	60	8.22	120	12.96
25	5.68	70	9.24	140	13.86
30	6.00	80	10.24		

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[7] Estimates made from data supplied by other U. S. Forest Service Experiment Stations and Regions.

These costs were originally developed for log hauling in parts of Utah, Montana, and Idaho, and have been adjusted for this study to reflect cord units and expected maintenance charges in the study area. These costs corresponded closely, over this large area and the hauling conditions encountered, with costs computed by more complicated "travel time" estimates based on the Byrne, Nelson and Googins studies (1960). They were both higher and lower than actual contract rates paid for log hauling in the study area. However, this is not serious in view of the wide range of rates encountered and the varying circumstances surrounding rate setting between contract parties.

In nearly all instances of long hauls, rail transportation can be used for most of the distance, combined with relatively short truck hauls to rail sidings. Based on proposed intrastate (Colorado) rail rates for pulpwood provided by local railroad officials, long-haul costs per cord generally can be minimized by using rail facilities where available at these longer distances (over 50 miles or so) from the millsites.

Road costs also important

Road costs may be expected to vary from one part to another of this large and varied area. For any given area, the road costs will depend on the kinds of road required, the number of miles and costs of such roads, and the volume of timber to which these costs may be charged.

New access roads will be required in many areas to utilize the forest resources fully. Pulpwood operators will be expected to stand their fair share of the costs. The total miles and location of roads needed to serve a particular millsite will have to be determined by consultation with local forest supervisors.

Current policy for road construction by timber operators in this area requires the construction of a road built to standards needed by a prudent operator to haul timber economically. Spur or work road costs may range from $200 to $1,000 a mile, while secondary access and main haul roads can range from $2,000 to $20,000 a mile.

Chippable sawmill waste is a low-cost supplement

Much of the pulpmill development in the West (and other areas of the United States as well) in recent years has been based on pulp chips made from the waste of other wood-using plants such as sawmills. As of 1960, about 40 percent of the pulp fiber source in the Pacific Northwest was chipped sawmill and veneer mill residue (Baker 1961).

At the present time, chippable sawmill residue might be obtained from a lumber production of 100 million board feet per year within and adjacent to the study area. This would yield approximately 50,000 tons of ovendry chips for pulping.

Even though this is only about 20 percent of the annual wood requirements of a 350-ton-per-day kraft pulpmill, it could be an important 20 percent if it cost less than alternative sources of pulpable wood.

Elsewhere, chipped mill waste delivered at the pulpmill is generally a less expensive pulping resource for the pulpmill than the chips produced from delivered roundwood. In the South, for example, pine pulp chips on a green-weight basis have an average price f.o.b. sawmill of around $6.00 a ton. This amounts to about $12.00 a ton on an ovendry weight basis. The average price paid for rough green southern pine pulpwood at local points of delivery in 1960 was $16.50 a cord (U. S. Forest Serv. and Agr. Stabil. Conserv. Serv. 1960). A green cord of southern pine pulpwood weighs about 2.5 tons (Taras 1956). The price per ton of ovendry roundwood pulpwood at local points of delivery is thus around $13.20 or $1.20 per ton more than a dry ton of chips, and this price--a cost to the pulpmill--does not yet include the cost of barking and chipping the wood.

Somewhat closer to the study area is a chip plant established in 1960 in the Black Hills of South Dakota to supply a Wisconsin pulpmill with chipped sawmill residue. The price of chips on a dry basis f.o.b. the chip plant is around $11.80 a ton. A ton of dry chips delivered at the Wisconsin mill costs the pulpmill somewhat less than the average price paid for a cord of pulpwood of comparable species in the Lake States in 1960 (U. S. Forest Serv. and Agr. Stabil. Conserv. Serv. 1960).

It is evident, therefore, that expansion of the lumber industry in the study area will enhance the attractiveness of the opportunity for producing pulp and paper here. Moreover, the existence of a pulpmill would represent a sizable market for chippable sawmill residue and would thus enhance, in turn, the attractiveness of sawmilling within and adjacent to the study area.

Substantial volumes of wood are available at moderate costs

In a broad way, table 3 shows how the pulpwood is distributed costwise with respect to each assumed Colorado River millsite. Figures 15 through 18 show the general pattern of these cost zones on the ground.

Table 3 suggests that a 350-ton-per-day newsprint mill at Kremmling might operate for about 40 years on wood that costs less than $20 a cord (less stumpage and roads) delivered to the mill at today's costs. This same mill could be sustained indefinitely with wood costing less than $25 per cord. Thus it appears that newsprint mills and other product mills of economically feasible size could count on an adequate supply of pulpwood at moderate costs over long periods of time.

Table 3.--Summary of total live green pulpwood volumes in current inventory available to assumed millsites by total procurement cost class, excluding stumpage and roads

Cost class (Dollars per cord)	Assumed millsite			
	Kremmling	Dotsero	Silt	Fruita
	Cords			
Less than 15.00	0	51,752	51,752	0
15.00-19.99	8,073,281	6,972,118	5,853,704	537,644
20.00-24.99	18,055,628	10,669,495	10,117,476	6,635,731
25.00-29.99	2,622,091	9,689,087	9,967,972	10,594,743
30.00-34.99	0	1,368,548	2,760,096	8,199,785
35.00-39.99	0	0	0	2,783,097
Total	28,751,000	28,751,000	28,751,000	28,751,000

OTHER FACTORS TO CONSIDER

The emphasis in the foregoing sections of this report has been on wood volumes, procurement costs, and water supply. Following are indexes of some other factors that may be useful in an appraisal of the suitability of the study area for location of pulp- and papermills.

A large regional paper market makes for lower paper distribution costs for local mills than for mills in outlying areas[8]

One of the more important factors about the market for paper immediately adjacent to the study area is the location of the major population centers of the Central Rockies. They are about as far removed from present paper-producing areas as it is possible to be in the United States (fig. 19). The relatively great distance of this area from present producing centers offers a local mill serving adjacent markets substantial paper shipping cost advantages compared to producers now serving this market.

Many kinds of paper and paper products can be made from such local timber species as lodgepole pine and Engelmann spruce pulped by the groundwood, sulfate, or semichemical processes. Much of the supply of these papers requires additional processing and remanufacture by converters, however, before it can be sold in this

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[8] Hathaway, C. R. The market outlook for a Colorado pulp and paper industry. 1959. (Unpublished report on file at the Rocky Mountain Forest and Range Expt. Sta., U. S. Forest Serv., Ft. Collins, Colo.)

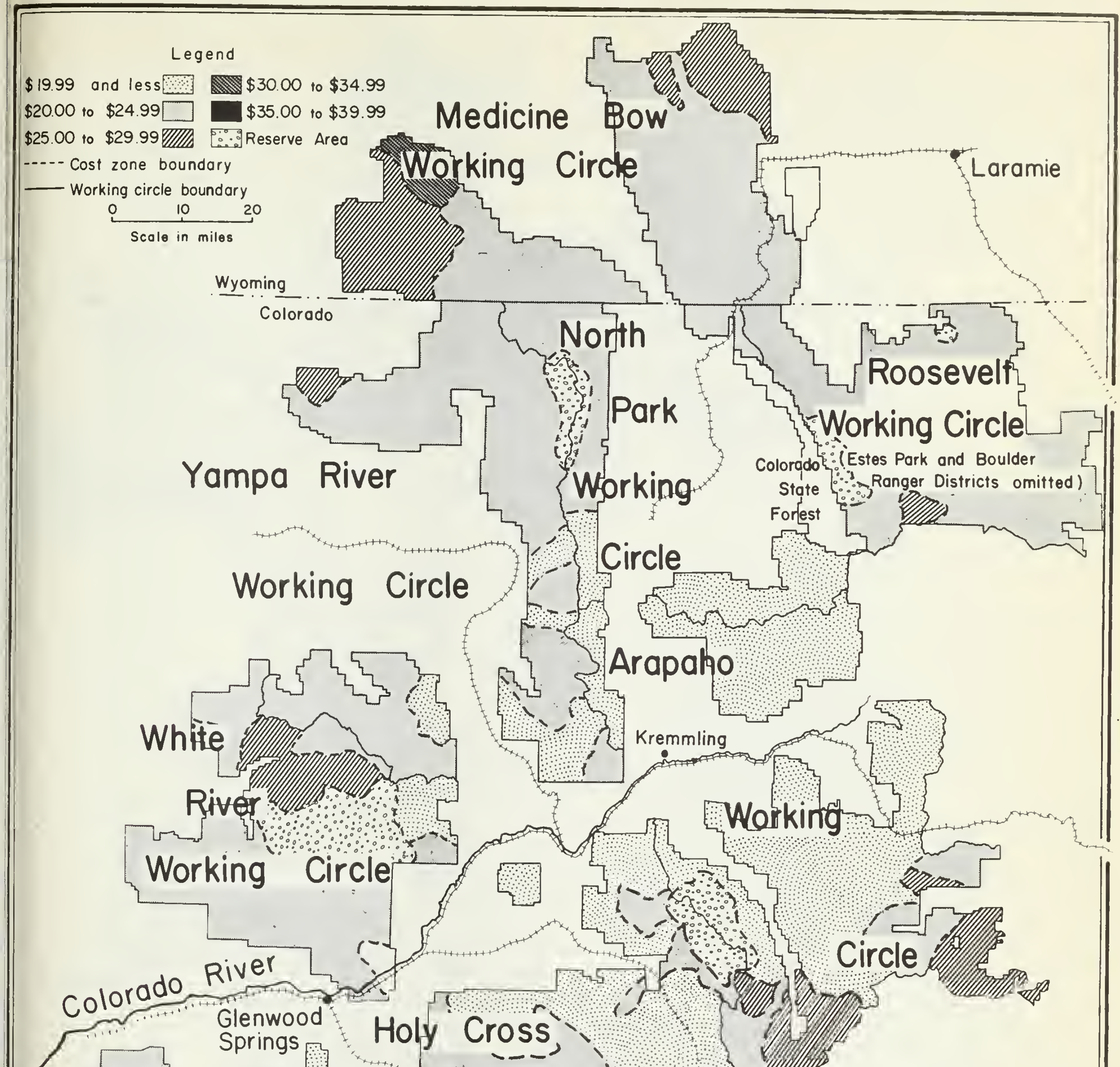

Figure 15.--Pulpwood procurement cost zones, Kremmling millsite.

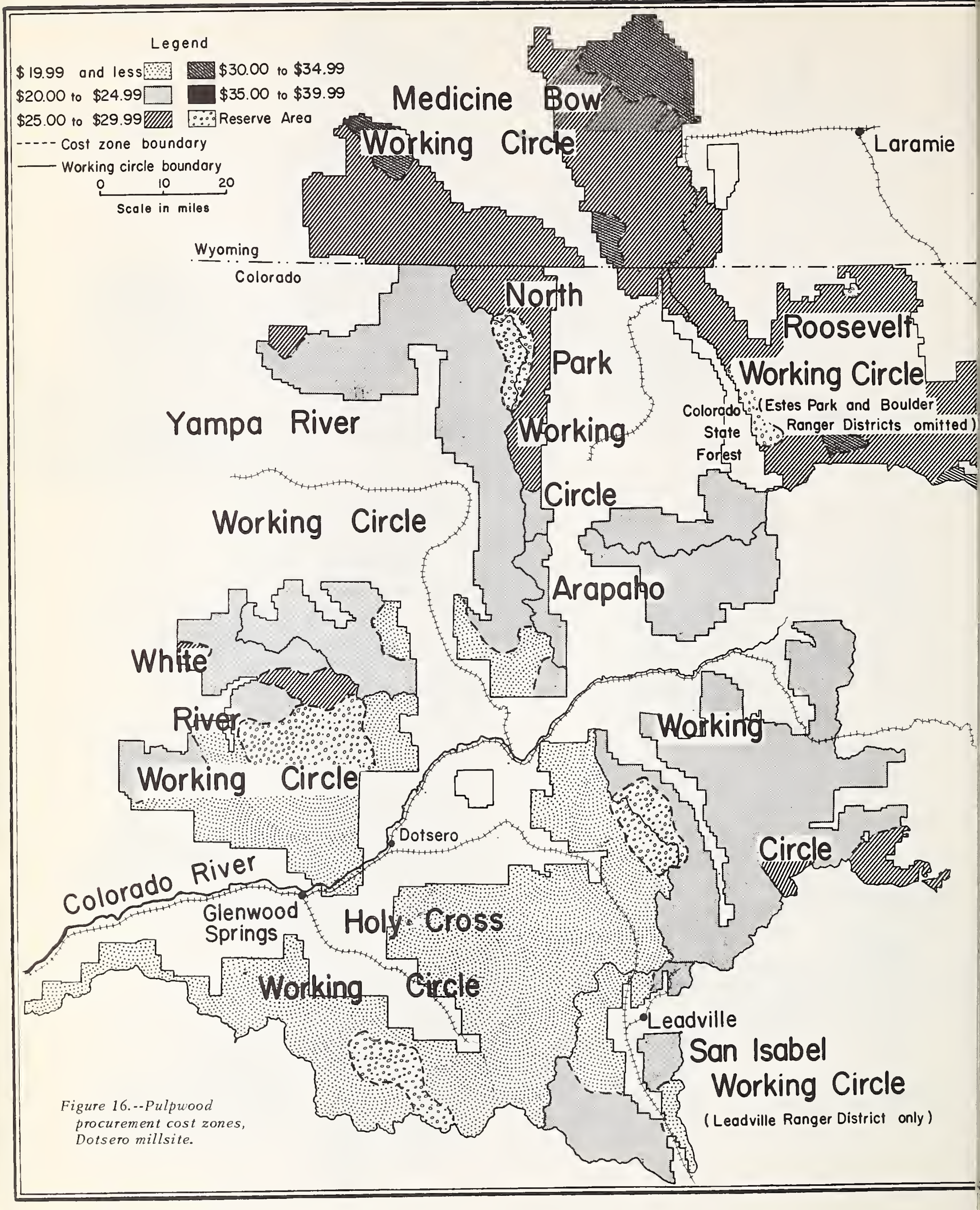

Figure 16.--Pulpwood procurement cost zones, Dotsero millsite.

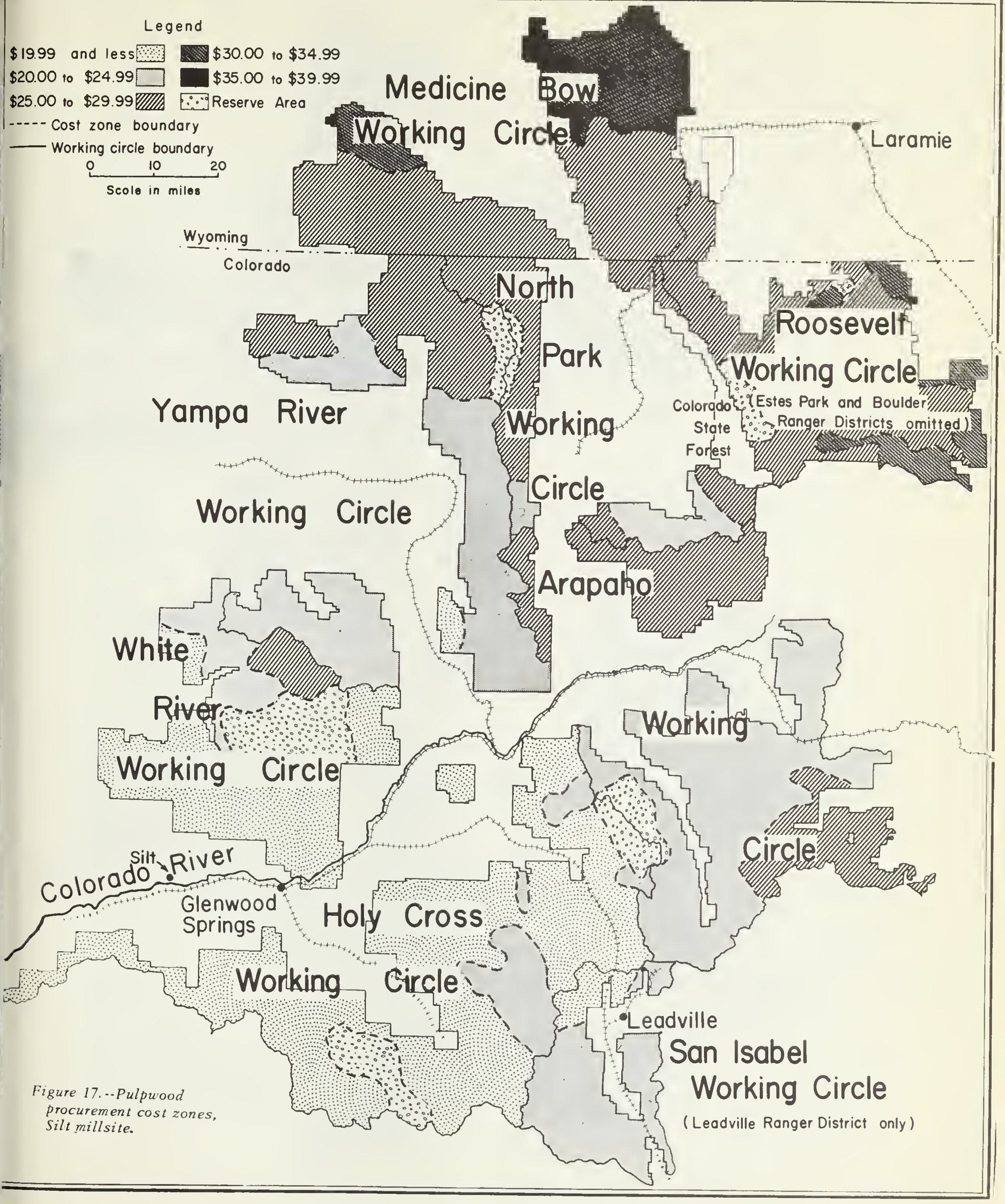

Figure 17.--Pulpwood procurement cost zones, Silt millsite.

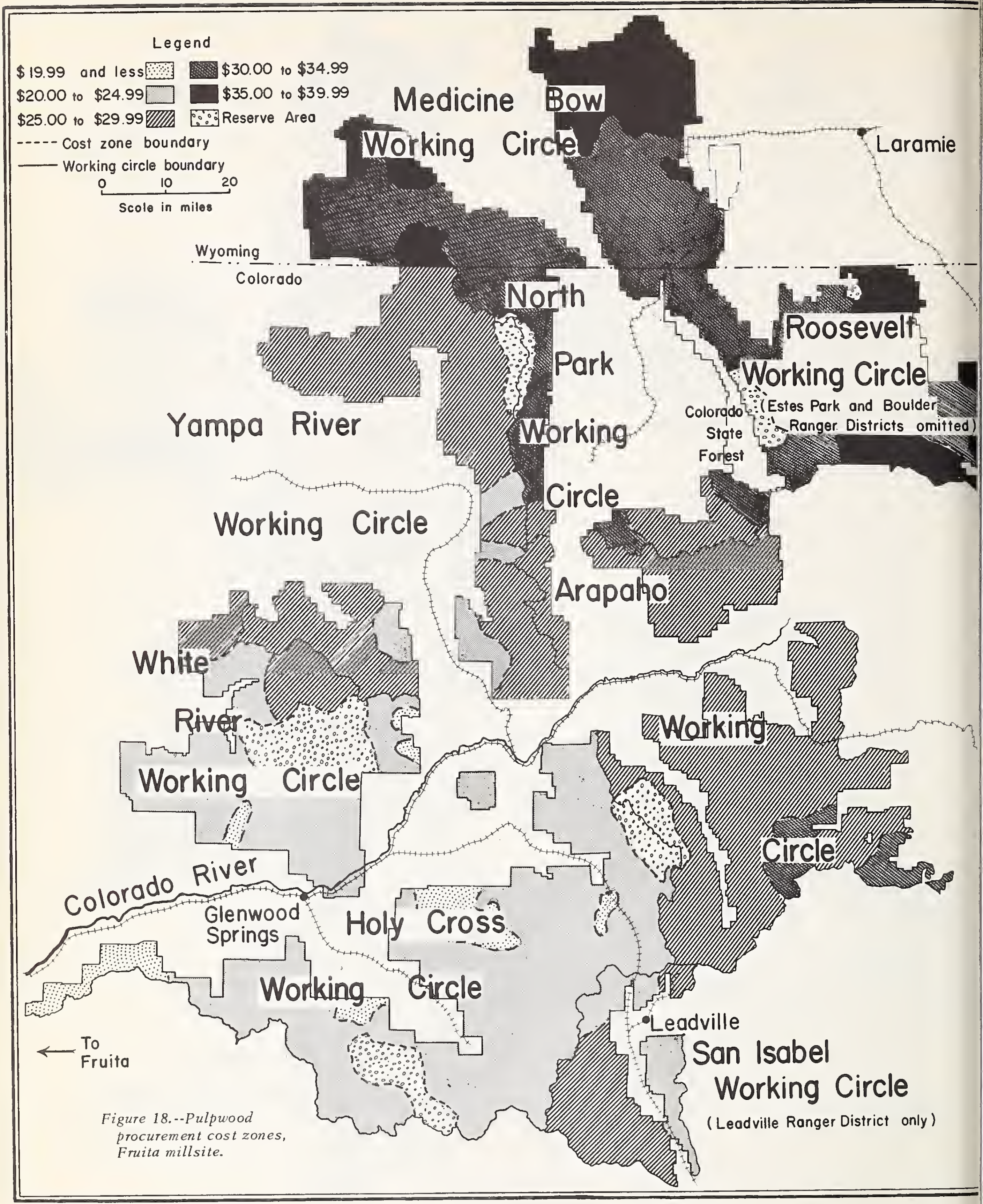

Figure 18.--Pulpwood procurement cost zones, Fruita millsite.

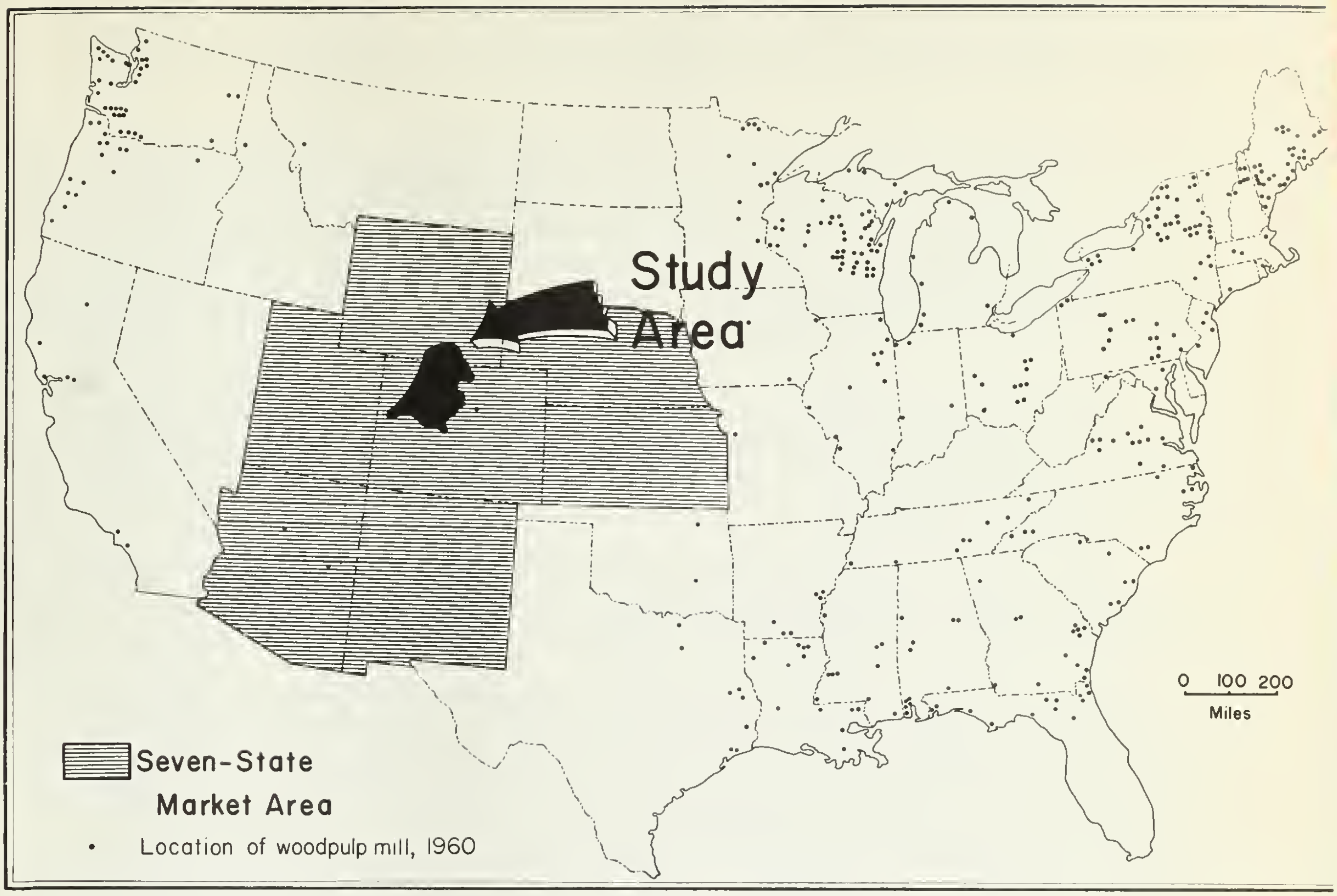

Figure 19.--The study area and adjacent markets are about as far from present pulp and paper producers as it is possible to be in the United States.

market area. About half of the paper consumed in Colorado and six adjacent States (Arizona, New Mexico, Wyoming, Utah, Kansas, Nebraska) is paper that has been remanufactured by folding, printing, combining with other media, or otherwise made into various kinds of paper products. The remainder of the paper consumed in this area is used by printers, publishers, converters, and as wrapping paper. Total consumption of all paper products in Colorado alone is estimated at over 285,000 tons a year. This is equivalent to about 840 tons of pulp and papermaking a day.

One of the largest markets is for newsprint, a product especially suited to manufacture from local timber species. Around 74,000 tons of newsprint are consumed in Colorado each year, with more than half of this consumption accounted for by one large Denver newspaper (Editor and Publisher 1958). If a 340-day work year in the papermill is assumed, the newsprint mill capacity required to fill the demand created by this one newspaper is about 120 tons a day. An estimated 190,000 tons of newsprint were consumed in 1958 in an area offering a freight advantage to a Colorado River-based mill.

Growth of the newsprint market appears favorable. Population and disposable income trends in Colorado and adjacent States indicate about a 40 percent increase in newsprint consumption for this area by 1970.

Another large market adjacent to the study area is the market for container board, including corrugated and solid fiber shipping container board and other boards made for the use of container manufacturers. About 117,000 tons of container board are consumed in a zone of freight advantage around the study area, and 45 percent of this amount--53,000 tons a year--is consumed in Colorado alone. Over 80 percent of this consumption is accounted for by firms who make containers in this area, with the remaining 20 percent made up of imported die-cut boxes ready for assembly and use.

There are two container-board manufacturers in Colorado and one in Arizona. One of the Colorado plants manufactures solid fiberboard from reclaimed waste paper. The remaining two container plants require 100 tons a day of liner board and corrugating material.

Use of container board in packaging produce and other products has been increasing steadily. Consumption of container board in Colorado and adjacent States is expected to increase an additional 60 percent by 1970.

Markets for special foodboard offer additional possibilities. Special foodboard is a high-grade folding board used to package milk, butter, ice cream, meat, and other food products. In 1957, half of the 58,000 tons of foodboard consumed in Colorado and adjacent States was made up within the area by converting plants. The remainder was shipped into the area already made up for use. A major increase in this market is forecast for 1970 and, presumably, some expansion of the converting facilities may also be expected. Such an increase in local converting facilities could represent a sizable market for local mills producing special foodboard.

Table 4 provides estimates of the amount of pulp- and papermaking capacity presently used to satisfy the paper consumption in Colorado and adjacent areas.

Anticipated paper freight costs from a Colorado River-based mill to the Denver market area are significantly lower than costs from competing areas. There are now no legal rates for paper shipped by rail from a Colorado River-based mill to various market areas. The railroad serving this area has indicated rate levels that would be proposed, however, should such traffic develop on this road. Comparisons of these proposed rail shipping costs with present rail costs from other producing areas to common destinations show that freight costs from a Colorado River-based mill to many of these common markets will be much lower. For example, the rail cost for shipping a ton of newsprint from a mill on the Colorado River to Denver would be $13.80 lower than the cost from western Oregon or northern Minnesota. It would be $12.20 cheaper than the cost from east Texas. Other newsprint rail freight cost advantages to a Colorado River-based mill to such destinations as Salt Lake City, Utah, and Santa Fe, New Mexico, range downward from $8.60 to $5.40 a ton.

Table 4.--Estimated paper mill capacity (mill operating 340 days a year) required to satisfy consumption of paper products in selected market areas around and including Colorado, 1957

Paper product	Colorado	7-State area	Zone of freight advantage
		Tons per day	
Newsprint	217	699	568
Printing paper	54	214	111
Fine paper	29	124	64
Coarse paper:			
Wrapping paper	13	66	51
Shipping sacks	29	125	70
Bags	30	146	117
Converter paper	30	133	114
Special industrial	17	80	65
Sanitary and tissue paper	46	237	215
Paperboard:			
Container board	156	689	344
Bending board	57	253	133
Special foodboard	18	170	52
Nonbending board	26	152	138
Building paper	52	186	113
Building board	61	218	133
Total	835	3,492	2,288

Costs for fuels, power, chemicals, taxes, and labor comparable to or less than same costs elsewhere

The costs for fuel per ton of pulp in Colorado may be expected to be comparable to or lower than the fuel costs in other pulp-producing areas of the United States. Applicable fuel rates were obtained from utility companies in various parts of the United States where pulp and paper manufacturing is concentrated.

For example, the approximate natural gas cost per ton of pulp in a 400-ton-per-day sulfate pulpmill in New York State would be about $3.00. In Wisconsin this cost would be about $2.50 per ton of pulp. Similar costs per ton of pulp would be even less, $1.90 on the average, in the Pacific Northwest. In the study area, by comparison, natural gas costs for 400 tons of sulfate pulping per day would average $2.00 per ton or perhaps less. The coal cost in the study area would average around $1.80 per ton of sulfate pulp.

The production of a ton of chemical pulp requires about 250 kilowatt hours of electric power (U. S. Forest Serv. 1958). Groundwood pulping requires at least five times this amount of energy. Thus a pulpmill in western Colorado would result in a significant increase in local energy consumption. There are several power companies capable of supplying the needed amounts of electricity, however. Power needs of the magnitudes contemplated for pulping in this area will require serious negotiation between customer and supplier in order to establish equitable rates.

The general rates in existence in the study area and elsewhere for various size classes of consumers indicate that electric power rates here will be about the same as they would be elsewhere for the amounts of electricity required to produce pulp and paper. Applicable electric power rates were obtained from several utility companies in the various parts of the United States where pulp and paper manufacturing is concentrated. For example, an illustrative rate for relatively large power users in New York in 1959 would have resulted in a cost per ton of sulfate pulp (400 tons of pulp per day assumed) of $2.73 without fuel adjustment. This compares with an expenditure of $2.68 for electricity in Wisconsin, $2.41 in Arkansas, as little as $1.68 in some portions of the Gulf States, and $1.64 for parts of Washington State. By comparison, one utility company serving a part of the Colorado study area has quoted a rate that would make the electric power cost of sulfate pulp about $1.88 a ton. Other local utility companies' charges in this area along the Colorado River would average about $2.20 per ton of pulp for a mill producing 400 tons of sulfate pulp a day.

This mineral-rich Rocky Mountain empire is capable of supplying most of the chemicals required for pulping. Compared with other pulp-producing areas, notably the South, the only chemical constituent that might be more expensive here is sulfur. Negotiation with local sulfur producers in Wyoming will be required. Salt cake can be obtained from West Coast suppliers at costs comparable to those incurred in other areas.

Hutchison and Wikstrom (1957) suggests that almost 34 man-hours are used in the production of a ton of paper--from stump through mill--by chemical processes. Groundwood pulping, the principal activity in newsprint manufacture, requires about 6 man-hours less to produce a ton of pulp.

Table 5 shows how hourly wages in Colorado forest products industries compare with like costs in other States where such industries are important.

Most of the taxes assessed against business in Colorado are similar to taxes incurred elsewhere. A guide to the taxes and fees applicable in Colorado, prepared by the Colorado Department of Employment, Division of Resources and Community Development, appears in the appendix, page 43.

Table 5.--Average hourly and weekly earnings in selected States for lumber and wood products and paper and allied industries, 1960[1]

State	Lumber and wood products			Paper and allied products		
	Hourly earnings	Weekly earnings	Weekly hours	Hourly earnings	Weekly earnings	Weekly hours
	Dollars		Number	Dollars		Number
Arkansas	1.29	53.53	41.5	2.38	98.29	41.3
Colorado	1.92	71.42	37.2	1.94	79.93	41.2
Georgia	1.22	46.97	38.5	2.30	94.99	41.3
Louisiana	1.30	55.90	43.0	2.40	97.20	40.5
Maine	1.53	62.83	41.0	2.28	104.86	46.0
Michigan	1.89	76.71	40.6	2.39	102.42	42.8
New York	1.89	76.63	41.2	2.16	91.57	42.4
Oregon	2.63	99.26	37.7	2.37	95.67	40.4
Washington	2.54	95.76	37.7	2.64	105.34	39.9
Wisconsin	1.69	69.29	41.0	2.34	102.75	43.9

[1] Source: Employment departments in subject States in cooperation with the Bureau of Labor Statistics. Compiled by Colorado State Department of Employment, Division of Resources and Community Development.

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APPENDIX

FOREST RESOURCE DATA

Definitions useful for interpreting the forest inventory data

Commercial forest.--Forest land that is producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. It includes areas presently inaccessible or inoperable which can become accessible and operable through prospective developments in roads, logging methods, and markets.

Forest type.--The species having the majority (or else the plurality) of cubic-foot volume of sawtimber trees in sawtimber stands, pole trees in poletimber stands, or number of trees in seedling-sapling stands was designated as the stand type.

Nonstocked areas.--Commercial forest lands less than 10 percent stocked with growing stock trees.

Reserved forest land.--Productive forest legally withdrawn from timber use.

Sawtimber trees.--Basic forest inventory data used prescribed a minimum diameter breast high of 11.0 inches. This minimum diameter was lowered to 9.0 inches for such species as lodgepole pine and Engelmann spruce in this study to reflect the broad product possibilities of the current inventory.

Poletimber trees.--Poletimber has a minimum diameter of 5.0 inches breast high and ranges up to the sawtimber size minimum.

Sawtimber stands.--Stands with a minimum net volume per acre of 1,500 board feet, International 1/4-inch rule, in trees of sawtimber size (11.0 inches d.b.h. and larger).

Poletimber stands.--Stands failing to meet the sawtimber specifications, but at least 10 percent stocked with poletimber and larger trees and with at least 5 percent stocking in poletimber trees.

Seedling and sapling stands.--Stands not qualifying as either sawtimber or poletimber stands, but having at least 10 percent stocking of trees of commercial species and with at least 5 percent in seedling-sapling trees (trees 6 inches in height to 4.9 inches d.b.h., inclusive).

Table 6.--Total live pulpwood and salvable dead volumes by forest types, species, and working circles within National Forest boundaries (current inventory)

(In M cords)

Commercial forest type and species	Medicine Bow	North Park	Yampa River	White River	Holy Cross	Roosevelt[1]	Arapaho	San Isabel[2]	Total
				LIVE PULPWOOD VOLUME					
TYPE--									
Lodgepole pine:									
Sawtimber	1,324	488	662	12	869	794	1,156	112	5,417
Poletimber	2,927	1,127	722	135	807	1,958	2,458	399	10,533
Spruce-fir:									
Sawtimber	714	444	748	232	1,401	387	1,526	203	5,655
Poletimber	197	82	82	158	347	40	272	122	1,300
Douglas-fir:									
Sawtimber	12	8	16	58	106	36	15	15	266
Poletimber	12	(3)	(3)	56	117	77	21	6	289
Ponderosa pine:									
Sawtimber	(3)	(3)	(3)	(3)	3	149	6	13	171
Poletimber	(3)	(3)	(3)	(3)	5	178	8	3	194
Aspen-hardwood	336	141	966	925	1,180	48	204	51	3,851
Other conifers	(3)	2	(3)	(3)	(3)	2	28	3	35
Dead spruce[4]	(3)	1	358	554	110	(3)	17	(3)	1,040
Total[5]	5,522	2,293	3,554	2,130	4,945	3,669	5,711	927	28,751
SPECIES--									
Lodgepole pine	3,630	1,223	1,022	226	1,329	2,439	3,299	403	13,571
Subalpine fir	1,013	594	1,060	571	1,113	478	1,048	179	6,056
Engelmann spruce	228	164	300	263	854	187	815	153	2,964
Douglas-fir	55	7	20	93	188	172	38	21	594
Ponderosa pine	1	(3)	1	4	13	240	12	12	283
Aspen-hardwood	502	282	1,124	946	1,347	99	444	135	4,879
Other conifers	93	22	26	29	102	53	54	24	403
Total[5]	5,522	2,292	3,553	2,132	4,946	3,668	5,710	927	28,750
				SALVABLE DEAD VOLUME[6]					
TYPE--									
Lodgepole pine:									
Sawtimber	621	311	421	6	428	304	503	55	2,649
Poletimber	317	166	107	8	50	145	312	25	1,130
Spruce-fir:									
Sawtimber	827	514	866	275	1,663	440	1,454	241	6,280
Poletimber	121	50	51	98	214	25	168	75	802
Douglas-fir:									
Sawtimber	2	1	3	10	18	6	3	2	45
Poletimber	1	(7)	(7)	3	7	4	1	(3)	16
Ponderosa pine:									
Sawtimber	(3)	(3)	(7)	(7)	(3)	13	1	1	15
Poletimber	(3)	(7)	(7)	(7)	(3)	10	(3)	(3)	10
Aspen-hardwood	102	43	295	282	360	14	62	16	1,174
Other conifers	(7)	1	(7)	(7)	(3)	1	12	2	16
Dead spruce	(7)	5	3,344	4,727	1,092	(7)	142	1	9,311
Total	1,991	1,091	5,087	5,409	3,832	962	2,658	418	21,448

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[1] Boulder and Estes Park Ranger Districts excluded.

[2] Compartments 001-008 only.

[3] Less than 500 cords.

[4] Live trees only.

[5] Differences due to rounding in compilation process.

[6] Only dead conifers within each type included.

[7] None sampled.

Table 7. --Total volumes of timber primarily suited for lumber and similar products by forest types, species, and working circles within National Forest boundaries (current inventory)
(In million board feet, International 1/4-inch scale)

Commercial forest type and species	Medicine Bow	North Park	Yampa River	White River	Holy Cross	Roosevelt[1]	Arapaho	San Isabel[2]	Total
TYPE--									
Lodgepole pine:									
Sawtimber	1,750	669	907	11	820	958	1,421	106	6,642
Poletimber	651	383	245	41	244	332	619	120	2,635
Spruce-fir:									
Sawtimber	1,447	659	1,111	395	2,391	684	2,643	346	9,676
Poletimber	55	23	23	44	97	11	76	34	363
Douglas-fir:									
Sawtimber	11	7	14	51	93	33	13	13	235
Poletimber	2	(3)	(3)	7	16	10	3	1	39
Ponderosa pine:									
Sawtimber	(3)	(3)	(3)	(3)	5	132	6	12	155
Poletimber	(3)	(3)	(3)	(3)	2	58	3	1	64
Aspen-hardwood	160	67	461	441	562	23	97	25	1,836
Other conifers	(3)	1	(3)	(3)	(3)	1	25	3	30
Dead spruce[4]	(3)	(3)	249	475	110	(3)	14	(3)	848
Total[5]	4,076	1,809	3,010	1,465	4,340	2,242	4,920	661	22,523
SPECIES--									
Lodgepole pine	2,228	909	1,055	119	982	1,133	1,948	205	8,579
Subalpine fir	367	294	644	386	562	105	322	68	2,748
Engelmann spruce	1,325	528	905	524	2,151	730	2,512	326	9,001
Douglas-fir	17	24	50	66	133	93	28	20	431
Ponderosa pine	2	1	2	8	20	162	10	12	217
Aspen-hardwood	135	52	353	361	480	17	76	25	1,499
Other conifers	1	(3)	(3)	2	11	3	24	4	45
Total[5]	4,075	1,808	3,009	1,466	4,339	2,243	4,920	660	22,520

[1] Boulder and Estes Park Ranger Districts excluded.

[2] Compartments 001-008 only.

[3] Less than 500 M b.m.

[4] Live trees only.

[5] Differences due to rounding in compilation process.

Table 8. --Pulpwood conversion factors for tree species common to the Colorado River study area

Species	Solid wood		Yield of moisture-free pulp[2]			Wood requirements to produce 1 short ton of air-dry pulp[4]		
	Volume per rough cord[1]	Moisture-free weight: green volume basis[2]	Sulfite	Sulfate	Groundwood	Sulfite	Sulfate	Groundwood
	Cu. ft.	Lbs./cu. ft.		Percent[3]			Rough cords	
Lodgepole pine	90	25	45	48	95	1.91	1.78	0.89
Engelmann spruce	90	20	48	47	95	2.23	2.28	1.11
Subalpine fir	87	21	48	48	95	2.22	2.22	1.10
Douglas-fir	85	29	48	48	95	1.62	1.62	.81
Ponderosa pine	76	24	45	48	95	2.37	2.23	1.11
Aspen	85	23	52	54	95	1.89	1.83	1.03
Other conifers	76	--	--	--	--	--	--	--
Dead spruce	95	--	--	--	--	--	--	--

[1] Best estimate available for local species, based on 128 cu. ft. per cord.

[2] Data taken from U. S. Forest Prod. Lab. Tech Note 191, "Density, fiber length, and yields of pulp for various species of wood." 5 pp., revised September 1953.

[3] Of moisture-free wood weight.

[4] Corrected for additional losses which reflect commercial practices.

WATER RESOURCE DATA

Colorado River average and minimum flow data have been compiled by the Colorado Water Conservation Board (table 10). The records for 1951-58 were tabulated since during that period both Granby and Green Mountain Reservoirs have been in operation.

Colorado River near Kremmling. --For flows above the mouth of the Blue River, the records are the sum of Colorado River at Hot Sulphur Springs, Williams River near Parshall, and Troublesome Creek near Troublesome. The latter gaging station was discontinued after 1956. The enlarged Williams Fork Reservoir will reduce the flows entering the Colorado River from the Williams River during periods of higher runoff. During later summer months and in the winter months, however, the demand at Shoshone will require the natural flows to be passed at the reservoir. The discharge of the Blue River has been added to indicate total flow in the Colorado River below the mouth of the Blue. The operation of the future Dillon Reservoir will reduce spills from Green Mountain Reservoir. Low flows in late summer and winter months will probably remain as they have been historically because of the Shoshone demand and power releases. The future operations of the three reservoirs mentioned will also similarly affect the streamflows as tabulated for the other selected points on the Colorado.

Colorado River above junction with Eagle River. --The data tabulated were calculated by subtracting flows of Eagle River below Gypsum from those of Colorado River near Dotsero.

Colorado River below Roaring Fork near New Castle. --The records tabulated 1951-58 are the sum of Colorado River at Glenwood Springs and Roaring Fork at Glenwood Springs. Records are available for Canyon and Elk Creeks for 1955-58. The sum of their discharges indicates the additional flows that would occur in the Colorado below the mouth of Elk Creek.

Colorado River below mouth of Gunnison River. --The flows tabulated are for the Colorado River near the Colorado-Utah State line. The record of this gage began in May 1951. Discharge at this station includes return flow from Grand Valley irrigation diversions, which would not be in the river immediately below the mouth of the Gunnison.

Table 9. --Typical waste loads from a modern kraft pulpmill and papermill (Pahren and Towne, 1960, p. 5)

Type of waste	Volume	5-day biochemical oxygen demands
	Gal./ton of pulp	Lbs./ton of pulp
Log haul-up spray water	250	0.6
Turpentine separator waste	35	2.0
Excess blow tank condensate and condensing water	1,000	3.2
Condensate from steam chests of black liquor evaporators	870	5.1
Condenser water of black liquor evaporators	13,000	6.0
Waste from pulp screening and paper machines	4,800	7.2
Water from bleaching operations	40,000	25.0
Total	59,955	49.1

Table 10. --Colorado River average and minimum daily flow for water years 1951-58
(In cubic feet per second)

Month	1951		1952		1953		1954		1955		1956		1957		1958	
	Average	Minimum	Average	Minimum	Average	Minimum	Average	Minimum	Average	Minimum	Average	Minimum	Average	Minimum	Average	Minimum
NEAR KREMMLING, ABOVE BLUE RIVER (gaging station discontinued after 1956)																
October	157	139	182	160	258	248	139	122	127	84	89	74	--	--	--	--
November	181	137	185	158	174	140	159	141	128	85	164	114	--	--	--	--
December	161	135	164	149	168	128	139	124	112	99	160	146	--	--	--	--
January	140	128	158	137	153	139	126	116	110	101	136	121	--	--	--	--
February	155	130	152	142	143	131	134	125	109	104	135	110	--	--	--	--
March	169	152	151	145	171	147	145	126	111	105	157	129	--	--	--	--
April	446	179	834	162	296	189	284	166	379	110	448	227	--	--	--	--
May	1,616	513	2,452	1,698	794	330	312	216	554	400	1,340	654	--	--	--	--
June	2,078	1,219	3,408	1,370	1,478	641	215	172	529	362	868	240	--	--	--	--
July	846	487	548	284	416	275	184	139	269	187	271	197	--	--	--	--
August	355	260	454	368	358	229	139	104	250	182	224	130	--	--	--	--
September	192	162	319	260	150	107	79	57	108	82	90	71	--	--	--	--
NEAR KREMMLING, BELOW BLUE RIVER (gaging station discontinued after 1956)																
October	338	170	538	250	584	274	518	212	425	231	546	145	--	--	--	--
November	406	177	481	213	464	183	318	154	333	205	475	156	--	--	--	--
December	430	182	546	272	462	174	417	149	262	225	449	257	--	--	--	--
January	588	320	396	164	390	160	487	139	261	232	428	287	--	--	--	--
February	516	309	376	202	433	155	433	228	227	208	490	430	--	--	--	--
March	470	200	557	220	516	165	607	168	251	212	538	427	--	--	--	--
April	991	346	1,605	310	903	207	705	333	521	263	857	494	--	--	--	--
May	2,881	1,806	4,009	3,207	1,454	727	590	326	852	524	2,536	1,194	--	--	--	--
June	3,633	2,488	4,983	3,240	2,924	2,130	350	249	899	640	1,875	633	--	--	--	--
July	2,199	1,748	1,743	1,003	1,277	930	713	464	662	400	821	670	--	--	--	--
August	1,227	594	1,109	746	1,080	771	800	555	757	574	779	613	--	--	--	--
September	286	500	798	632	660	437	519	214	802	597	901	679	--	--	--	--
ABOVE EAGLE RIVER																
October	545	433	854	643	763	697	795	550	646	442	810	461	932	619	892	672
November	626	408	762	556	803	578	631	475	561	360	665	381	615	467	840	673
December	687	419	768	390	695	375	665	450	420	310	638	524	469	320	735	470
January	793	425	612	291	770	557	765	520	423	320	613	485	538	355	772	566
February	842	532	579	432	736	421	661	442	439	330	639	524	612	490	807	700
March	719	554	770	430	851	507	843	548	508	370	840	605	613	577	935	797
April	1,356	620	2,424	704	1,321	580	1,119	700	1,128	627	1,572	946	1,269	575	1,434	1,013
May	4,248	2,165	6,844	5,380	2,517	1,336	1,375	879	2,067	1,396	4,552	2,236	4,427	2,800	5,709	1,849
June	5,612	4,070	8,025	4,650	5,023	2,500	631	411	2,080	1,260	3,436	1,089	9,240	5,760	4,400	2,400
July	2,724	2,131	2,549	1,760	1,801	1,352	901	490	968	688	1,169	928	5,805	3,450	1,217	923
August	1,532	840	1,748	1,272	1,516	1,021	949	731	1,014	828	1,056	787	2,048	1,355	866	783
September	1,009	867	1,133	846	876	728	734	548	959	774	1,055	755	1,045	774	800	698
BELOW ROARING FORK																
October	1,297	982	1,804	1,449	1,761	1,312	1,511	1,398	1,652	1,327	1,362	1,159	1,451	1,180	1,922	1,654
November	1,387	1,092	1,562	1,161	1,612	1,204	1,433	1,242	1,289	936	1,383	992	1,289	986	1,840	1,447
December	1,333	1,030	1,444	975	1,424	960	1,351	984	1,042	800	1,268	994	1,040	716	1,591	1,240
January	1,340	804	1,241	798	1,445	1,186	1,350	1,028	965	800	1,163	965	1,117	848	1,513	1,219
February	1,399	1,083	1,140	912	1,336	936	1,187	920	912	732	1,149	807	1,107	890	1,487	1,333
March	1,328	966	1,353	918	1,505	1,084	1,316	984	1,008	850	1,481	1,032	1,164	1,008	1,612	1,403
April	2,390	1,214	4,504	1,445	2,270	1,241	1,943	1,282	2,122	1,118	2,756	1,632	2,210	1,164	2,325	1,740
May	8,526	3,494	13,384	8,930	5,374	2,415	4,007	1,774	5,283	3,350	10,117	3,890	8,135	4,049	12,491	2,872
June	13,620	9,490	21,087	11,810	13,958	7,270	3,058	2,550	6,773	4,480	9,485	3,540	22,831	12,350	12,648	5,520
July	7,412	4,880	6,843	4,350	4,475	2,766	2,229	1,704	3,175	2,220	2,632	1,980	17,311	9,030	2,741	1,965
August	3,184	1,978	4,028	3,160	2,851	1,912	1,659	1,265	2,197	1,712	1,825	1,405	4,925	3,180	1,623	1,432
September	1,781	1,544	2,476	1,869	1,598	1,360	1,507	1,145	1,488	1,288	1,508	1,326	2,374	1,858	1,565	1,424
ELK CREEK, PLUS CANYON CREEK (Tributary to Colorado River)																
October	--	--	--	--	--	--	--	--	45	42	11	7	8	2	39	11
November	--	--	--	--	--	--	--	--	42	31	32	21	29	23	55	45
December	--	--	--	--	--	--	--	--	41	34	41	31	31	27	57	49
January	--	--	--	--	--	--	--	--	38	33	39	29	31	26	47	40
February	--	--	--	--	--	--	--	--	34	26	33	28	28	24	48	38
March	--	--	--	--	--	--	--	--	34	25	40	30	30	24	47	44
April	--	--	--	--	--	--	--	--	55	25	95	44	58	38	77	43
May	--	--	--	--	--	--	--	--	645	160	790	163	316	84	951	96
June	--	--	--	--	--	--	--	--	558	155	417	39	1,762	1,064	827	98
July	--	--	--	--	--	--	--	--	32	8	14	3	679	96	34	8
August	--	--	--	--	--	--	--	--	24	6	4	3	47	21	4	3
September	--	--	--	--	--	--	--	--	5	4	3	2	43	18	13	3
NEAR COLORADO-UTAH STATE LINE																
October	--	--	2,726	2,370	2,683	2,420	2,548	1,880	3,213	2,640	1,932	1,820	1,916	1,700	4,206	2,350
November	--	--	2,967	2,570	2,999	2,320	3,179	2,840	2,685	2,400	2,726	2,240	2,549	2,160	4,411	3,470
December	--	--	2,832	2,000	2,910	2,050	2,452	1,800	2,214	1,800	2,650	2,200	2,071	1,720	3,543	2,990
January	--	--	2,830	2,200	2,799	2,440	2,477	2,000	2,057	1,800	2,353	2,000	2,248	1,730	2,881	2,320
February	--	--	2,431	2,140	2,514	2,180	2,321	2,090	2,060	1,700	2,293	1,800	2,587	1,850	3,486	2,810
March	--	--	2,810	2,200	2,802	2,360	2,464	2,170	2,907	2,000	2,792	2,060	2,494	2,290	3,625	3,240
April	--	--	11,290	3,470	3,557	2,160	3,013	2,080	4,265	2,570	5,056	3,220	4,878	2,660	7,379	3,670
May	12,340	3,660	30,500	19,400	8,905	2,840	6,256	2,640	10,130	6,400	15,640	6,000	18,710	5,510	28,820	8,320
June	19,960	13,600	36,080	17,900	22,051	9,480	3,481	2,820	10,760	6,600	14,270	3,770	43,830	29,900	23,960	9,200
July	8,661	5,050	9,887	4,380	5,341	2,860	2,341	1,700	3,233	1,820	2,553	1,390	29,590	17,400	3,349	1,980
August	3,616	2,030	5,451	4,250	3,888	2,270	1,514	1,000	2,703	1,860	1,672	1,000	9,183	5,750	1,692	1,200
September	2,278	1,900	3,427	2,640	2,142	1,880	2,496	1,150	1,814	1,400	1,361	960	4,379	2,760	2,437	1,280

Table 11. --Pertinent waste disposal characteristics of selected river stretches in western Colorado during the critical month (August)

River and stretch	10-year low flow expected in critical month	Expected water temperature	Approximate dissolved oxygen saturation level	Safe 5-day 20°C BOD assimilative capacity
	c.f.s.	Centigrade	p.p.m.	pounds
Colorado:				
Parshall-Kremmling	475	20°	6.85	17,500
Sweetwater-Dotsero	950	22°	7.00	30,000
New Castle-Rifle	1,300	24°	7.00	32,000
Grand Junction-Fruita	1,000	25°	7.05	20,000
White:				
Buford-Meeker	210	24°	6.60	3,500
Eagle:				
Eagle-Gypsum	140	23°	6.80	7,500
Gunnison:				
Gunnison-Delta	[1]200	25°	6.90	3,000
North Fork Gunnison:				
Somerset-Hotchkiss	87	20°	7.50	3,500

[1] Reflects flows expected from construction of Paonia project on North Fork of Gunnison.

Table 12. --Specifications for chemical composition of process water for various pulp and paper products

Substance	Maximum p.p.m. by product				
	Fine paper	Bleached kraft paper	Unbleached kraft paper	Groundwood papers	Soda and sulfate pulps
Turbidity as SiO_2	10	40	100	[1]50	[1]25
Color in platinum units	5	25	100	30	5
Total hardness as $CaCO_3$	100	100	200	200	100
Calcium hardness as $CaCO_3$	50	(2)	(2)	(2)	50
Alkalinity to methyl orange as $CaCO_3$	75	75	150	150	75
Iron as Fe	0.1	0.2	1.0	0.3	0.1
Manganese as Mn	.05	.1	.5	.1	.05
Residual chlorine as Cl_2	2.0	(2)	(2)	(2)	(2)
Silica (soluble) as SiO_2	20	50	100	50	20
Total dissolved solids	200	300	500	500	250
Free carbon dioxide as CO_2	10	10	10	10	10
Chlorides as Cl	(2)	200	200	75	75

[1] Materials causing turbidity shall not be gritty.

[2] Not applicable.

MAJOR TAXES AND FEES APPLICABLE TO A NEW INDUSTRY LOCATING IN COLORADO

Corporate organization and qualification fees

New domestic corporations, upon organization, must pay the Secretary of State a fee based upon the amount of authorized capital stock as follows:

FILING FEES
(Articles of Incorporation)

	Filing and certificate	10% fee old age pension	Total fee
Less than $50, 000	$ 25.00	$ 2.50	$ 27.50
$50, 000 and less than $150, 000	40.00	4.00	44.00
$150, 000 and less than $250, 000	55.00	5.50	60.50
$250, 000 and less than $500, 000	85.00	8.50	93.50
$500, 000 and including $1, 000, 000	165.00	16.50	181.50
Add 20 cents for each $1, 000 or fraction thereof over $1, 000, 000.		.02	.22

When capital stock is increased, the above fees are charged and a credit is given for amounts previously paid. For the purpose of computing filing fees for no-par value stock, the stock is valued at $1.00 per share.

A fee of $60 is charged foreign corporations for a Certificate of Authority to transact business in Colorado.

Corporate franchise tax

All profit-making domestic and foreign corporations authorized to transact business in Colorado are subject to a franchise tax, which is due at the time of incorporation or at the time the annual report is filed. The tax is based upon the amount of authorized capital stock as shown in the following table. No-par value stock is valued at $1.00 per share.

If the authorized capital stock is:	The tax is:
Less than $50,000	$ 10.00
$50,000 but less than $100,000	$ 20.00
$100,000 but less than $250,000	$ 40.00
$250,000 but less than $500,000	$ 65.00
$500,000 but less than $1,000,000	$100.00
$1,000,000 or MORE	$250.00

A fee of $5.00 is charged for filing annual reports with the Secretary of State. The amount of franchise tax due is based on information given in the company's annual financial report.

Income tax

Corporate Income Tax.--Corporations in Colorado must pay a corporate income tax of 5 percent on the net income of the corporation. Federal corporate income taxes are not deductible in computing the company's Colorado corporate income tax liability.

Colorado has a law relating to the allocation or apportionment of income: C.R.S.138-1-28. In general, the entire net income of corporations shall be allocated or apportioned as follows:

A. Interest, which shall not include service or carrying charges or discount earnings, received from intangible personal property not used in connection with the business of the corporation and not properly included in the inventory thereof, less related expenses, shall be allocated to the State in which the principal place of business is located.

B. Dividends received from and gains realized from the sale of corporate stocks, less related expenses, shall be allocated to the State in which the principal place of business of the corporation is located.

C. Royalties or similar income received from the use of patents, trademarks, copyrights, secret processes and other similar intangible rights, less related expenses, shall be allocated to the State in which the principal place of business of the corporation is located.

D. Rents received from the lease or rental of real property or tangible personal property, less related expenses, shall be allocated to the State in which the property is located during the period for which the rent is earned.

E. Gains or losses realized from the sales of capital assets, such as shall consist of real property or tangible personal property, less related expenses shall be allocated to the State in which such assets are located.

F. The remainder of the net income not specifically allocated in A to E above shall be allocated or apportioned as follows:

1. If the corporation carries on no business outside of the State of Colorado, the whole of the remainder of the net income shall be allocated to this State.

2. If the corporation derives income from sources both within and without the State of Colorado, the said remainder of the net income shall be divided into two equal parts:

a. Of one-half, such portion shall be attributed to sources within this State as shall be found by multiplying the said one-half by a fraction, the numerator of which is the value of all of the real property and tangible personal property of the corporation situated within this State, and the denominator of which shall be the value of all the real property and tangible personal property of the corporation wherever situated.

b. Of the other one-half, such portion shall be attributed to the sources within this State as shall be found by multiplying the said one-half by a fraction, the numerator of which is the amount of gross receipts assignable to this State as hereinafter provided and the denominator of which is the amount of gross receipts from all its business.

Personal Income Tax. --Colorado's personal income tax, based on net income, ranges from 3 percent on a net income of less than $1, 000, increasing progressively by 1/2 percent steps to 9 percent on all net income in excess of $10, 000. A $750 per-dependent exemption is allowed in addition to deductions for the full amount of Federal income taxes and the full amount of all medical expenses in any one taxable year.

The Colorado Department of Revenue suggests that employers withhold from 10 to 18 percent of the Federal withholding amount to cover the Colorado personal income tax liability. The suggested withholding schedule is as follows:

MONTHLY PAY PERIOD

Federal Withholding		Colorado percentage of Federal Withholding
At least	But less than	
$ 0	$ 74.10	10%
74.10	148.10	15%
148.10	and over	18%

INDIVIDUAL INCOME TAX SCHEDULE

If the Net Taxable Income is: Over	But not over	The Normal Tax shall be:
$ 0	$ 1,000	3% of net taxable income
$1,000	$ 2,000	$ 30 plus 3½ % of excess over $ 1,000
$2,000	$ 3,000	$ 65 plus 4% of excess over $ 2,000
$3,000	$ 4,000	$105 plus 4½ % of excess over $ 3,000
$4,000	$ 5,000	$150 plus 5% of excess over $ 4,000
$5,000	$ 6,000	$200 plus 5½ % of excess over $ 5,000
$6,000	$ 7,000	$255 plus 6% of excess over $ 6,000
$7,000	$ 8,000	$315 plus 6½% of excess over $ 7,000
$8,000	$ 9,000	$380 plus 7% of excess over $ 8,000
$9,000	$10,000	$450 plus 8% of excess over $ 9,000
All over $10,000		$530 plus 9% of excess over $10,000

Statistics from the Department of Revenue show that a married person with two children, filing a joint return, with a gross income of $10,000, would pay a normal State income tax of $180.50.

Property taxes

Ad valorem.--All business property, real and personal, is subject to taxation unless expressly exempt. There is no property tax on non-business personal property. The basis for assessment is the current market value of the property. Assessment practices may vary slightly from county to county and for this reason it is suggested that interested parties check with the county assessor in the subject county.

A sales ratio study for each Colorado county was conducted by the Colorado Legislative Council for the period July 1957 through December 1960 and is being used as a method of distributing State aid to school districts.

The average State-wide sales ratio for all classes of property combined is 27.3 percent of its present value. The average sales ratio for industrial properties in Colorado is 34.6 percent.

The rate of the State ad valorem tax is limited by the constitution to 5 mills. However, the State is gradually removing itself from ad valorem taxation. As evidence of this, the Legislature has reduced the State levy from 3.56 mills to 1.42 mills in the past 4 years.

The bulk of the property taxes occur at the local level and vary considerably among counties. Because of varying local conditions, it is impossible to make a specific statement about taxation rates at the local level. In all cases, there will be a county ad valorem tax and a school district tax. If the firm is located inside corporate city limits, there will be a city property tax in addition to the State, county, and school taxes. Also, there may often be a levy for a special improvement district tax.

All State and local taxes levied for any particular area can be determined by contacting the local assessor or by referring to the annual report of the Colorado Tax Commission.

Assessment of business personal property

The Business Personal Property Tax is levied on all business property used in the operation of a business for profit, such as merchandise, machinery and equipment, and furniture and fixtures. Assessment practices may vary slightly from county to county, and for this reason, it is suggested that interested parties check with the county assessor in the subject county.

Merchandise and manufactures. --In listing the amount invested in merchandise or manufactures, the statutes provide that the taxpayer making the list shall state the amount invested in such merchandise or manufactures, or furnish figures from which the assessor can determine this amount. Three methods can be used by the assessor, (1) end of month figures, with a twelve month average, (2) quarterly figures, with a four-quarter average, or (3) opening and closing inventory, with cost of goods sold for prior calendar or fiscal year as shown on Colorado State Income Tax Return for that year. Once a taxpayer has selected one of these methods he cannot change it without approval of the County Assessor. For the tax year, 40 percent of such amounts will be used in computing the assessed valuation. Limited discretionary powers are granted to the assessors in determination of the assessment ratio.

Machinery and equipment, furniture and fixtures. --Such items are to be assessed at 40 percent of "as is" value, but at not less than 20 percent or original cost.

Unemployment compensation. --In general, employers in private business who employ four workers for some part of a day in each of twenty different calendar weeks during any calendar year, are subject to the Colorado Employment Security Act. The tax rate for a new employer of four or more employees is 2.7 percent of the first $3,000 of each employee's wages for the first three calendar years in which he is subject to the Act, regardless of his experience. The new employer becomes eligible for an experience rating beginning the fourth calendar year.

Based upon the employer's experience rating, he receives a computed tax rate of between zero and 2.7 percent. The two main factors affecting the rate are: (1) Employers individual experience (total taxes credited to account less job insurance benefits charged against account), and (2) the balance of the State Fund as of July 1 of each year.

Because of Colorado's relatively stable economy, unemployment compensation costs are among the lowest in the country. In 1961 the average employers' contribution rate was 0.8 percent as compared to 2.1 percent nationally. Preliminary figures for 1962 indicate that Colorado will again have one of the lowest rates in the nation.

Generally, an employer, subject to the provisions of the Colorado Employment Security Act, will be required to file an Annual Federal Tax Return of Employers to the Internal Revenue Service with a remittance of 0.8 percent of the taxable wages for 1962. If an employer has a rate other than 2.7 percent with the Colorado Department of Employment, he still remits the 0.8 percent to the District Director of the Internal Revenue Service.

Workmen's Compensation Act of Colorado and Colorado Occupational Disease and Disability Act

Employers of four or more workers are required by law to carry insurance for the protection of employees covered by the Workman's Compensation Act. Employers may obtain their insurance from the State funds, from a private insurance carrier of their choice, or if they employ 200 or more workers, they may provide their own insurance, when authorized by the Commission, by depositing a predetermined sum of money in trust or in escrow in a local bank.

The insurance rates are the manual rates passed or approved each year by the Colorado State Industrial Commission. The State fund rate is currently 30 percent under the manual rate.

Similar insurance provisions apply to the Colorado Occupational Disease and Disability Act. The employer again has the right of selection of his insurance carrier

Other taxes

There are other miscellaneous taxes that may affect certain operations. For example, employers operating their own trucks are subject to ton-mile and motor fuel taxes, depending upon the kind of operation involved.

Moreover, there are certain Federal taxes that apply nationwide. These rates should be similar, however, no matter where they apply.

The Colorado State Department of Employment, Division of Resources and Community Development, will be happy to answer inquiries relating to Colorado State taxes or refer such inquiries to other State agencies for reply.

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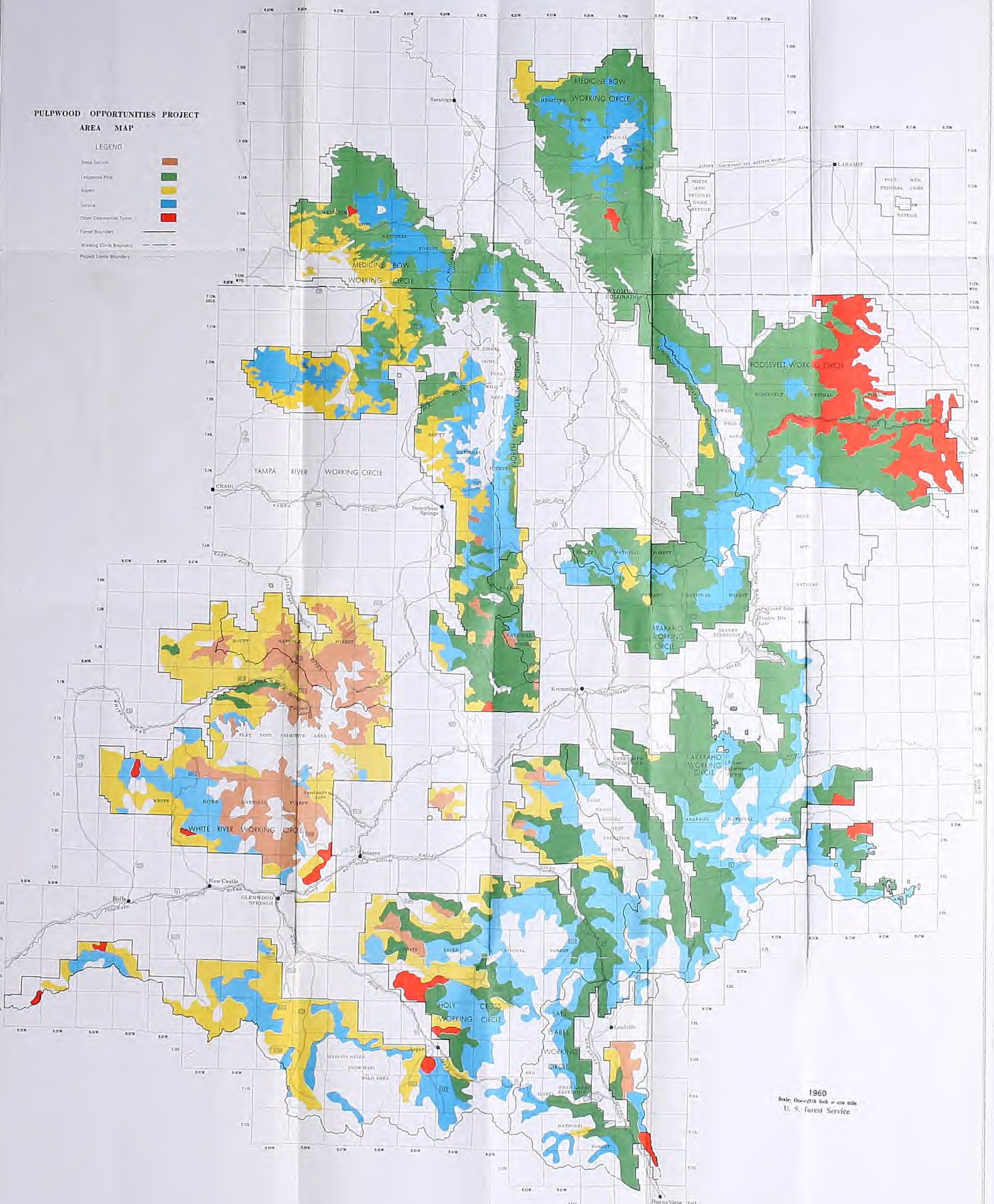
PULPWOOD OPPORTUNITIES PROJECT AREA MAP



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Scale: One-eighth inch = one mile

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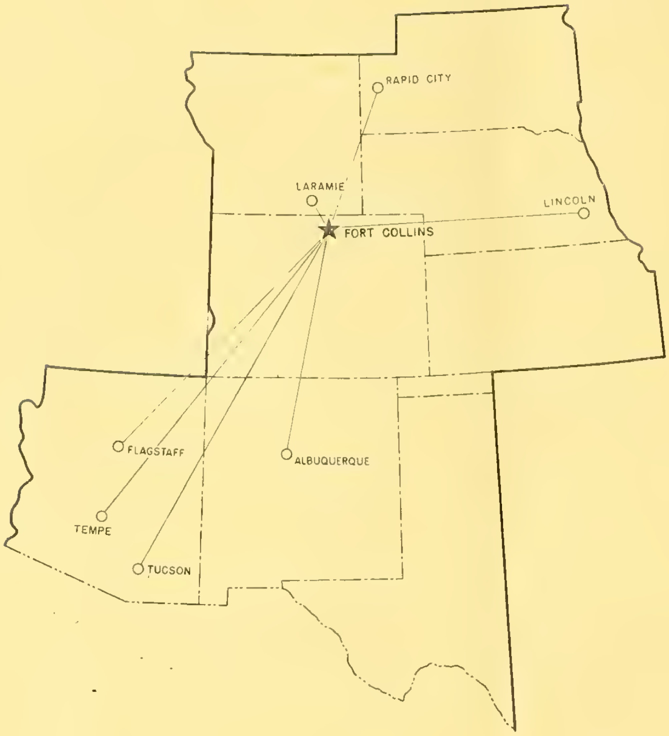

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